PRECIOUS STONES AND GEMS

Edwin W. Streeter.

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Oat

PRECIOUS STONES

AND

GEMS,

THEIR HISTORY, SOURCES AND CHARACTERISTICS.

BY

EDWIN W. STREETER, F.R.G.S., M.A.I.

Gold Medallist of the Royal Order of Frederic:
Holder of a Gold Medal from H. M. the King of the Belgians;
Author of "Pearls and Pearling Life;"
"The Great Diamonds of the World;"
"Gold; its Legal Regulations and Standards," &c., &c.

Illustrated.

FIFTH EDITION,
REVISED AND LARGELY RE-WRITTEN,
WITH CHAPTERS ON THE RUBY MINES OF BURMA.

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CORRIGENDA.

PAGE 184, line 4.—*For* " Mr. Crostwaithe," *read* " Mr. (now Sir Charles) Crosthwaite."

PAGE 218, line 22.—*From* " the late Mr. Greville Williams " *omit* " the late."

TO THE READER.

MANY works have been written on the fascinating subject of PRECIOUS STONES. Authorities on authorities, from remote antiquity to our own day, have been cited as to their value, their uses, and their properties. But, notwithstanding all that has been written, I have arrived at the deliberate conviction, that, as a merchant and dealer engaged for forty-five years in the purchase and sale of gems, I might serviceably offer to the public much information regarding the nature, the sources, and the value of these stones. A practical and popular guide to those who have an interest in ascertaining the genuineness and value of Precious Stones cannot fail to be generally useful.

As an illustration of the difficulties of the subject, it may be stated that Professor A. H. Church, in a lecture delivered before the Society of Arts on April 6th, 1881, pointed out a number of errors in the identification of a collection of Precious Stones which had been exhibited for years at the South Kensington Museum, although the official description of these stones had been confided to a well-known professor of mineralogy and expert in gems. I

have reason to believe that other collections, on the Continent, if not in this country, contain many specimens of Precious Stones erroneously named.

In the division of family jewels much injustice is often done by persons incompetent to form a correct opinion of their values. A study of this work may serve to demonstrate the difficulty of an accurate discrimination. In all cases, whether for valuation or for probate, it would be wise to submit the jewels to a practised judge, and it is obviously inexpedient to leave the decision to some house agent or mutual friend.

A lady had bequeathed to her some family jewels, consisting of a Sapphire and Diamond suite. As they had passed probate several times, and been valued by one of the first jewellers of the day, there was no doubt in the mind of the legatee of the genuineness of the Sapphires. On being applied to in relation to their value, I had the unpleasant duty of pronouncing the "Sapphires" to be only paste. Had they been genuine they would have realised from £30,000 to £40,000.

One often sees the Spinel and the Balas—the one a lively poppy-red, and the other a violet-rose—usurping the dignity of the true Ruby ; and yet the pure Ruby of ten carats is almost beyond valuation, while the other stones, called by the same name, are of only trifling value.

A gem should be a real possession, capable of affording pleasure to the wearer and the spectator, and, with fair usage, retaining an intrinsic and marketable value, undiminished by lapse of time. I have sometimes seen in wear gems so scratched that their lustre has been seriously impaired, and a suspicion was thus excited in the minds of wearers, friends, and dealers, that there was a defect in

the hardness of the stones, and consequently in their genuineness. If mounted stones are carelessly kept together and allowed to rub against each other, the Diamonds will inevitably scratch all the other stones, and thus disfigure them. It may be worth while to point out that a small sum expended in re-polishing such stones would restore their original lustre, revive the pleasure derived from the possession of them, and prevent the risk of their being sold as paste or imitation jewelry.

In determining the value of gems, it must be borne in mind that a perfect stone is rarely met with; and that probably, not even ten per cent. of the stones which are brought into commerce are really of fine quality. In the mineral kingdom, as in other departments of Nature, perfection is almost unknown.

Much study and attention will be required to attain a knowledge of the properties and appearance of gems; but the subject, so far from being unattractive, is to most persons of culture one of singular interest.

With objects such as those referred to above, I am publishing the present volume, which is the fifth edition of the original work; and I hope that in the revised and enlarged form, which it now presents, it may be of some service to those who have occasion to handle Precious Stones as a matter of business, and to the public in general.

It must be borne in mind that this book is not intended to be a strictly scientific treatise, but rather a practical work for those who, whether in the trade or among the public at large, desire to obtain some knowledge of the general characteristics of Precious Stones and Gems.

In conclusion, I trust that the Goldsmiths' Company, as fathers of the trade, will ere long throw open their fine suite of rooms in Foster Lane, and will not only establish a comprehensive library of books bearing on the study of jewelry, but by giving gratuitous Lectures on Precious Stones and Precious Metals, will offer that aid to the younger members of our trade, which is necessary for a proper understanding of their daily business. To this Company we must also look for aids to the more general appreciation of fine art jewelry, by affording favourable opportunities for exhibitions, and by awarding prizes, similar to those offered by the Turners' Company. This would give an impetus to study to those engaged in jewelry-work, and would enable the public to obtain a more accurate knowledge of, and to take a deeper interest in, a subject which has hitherto remained the property of an exclusive few.

The legacies bequeathed to the Goldsmiths' Company by the famous goldsmiths and jewellers of the 15th, 16th, and 17th centuries, which have since increased in value to an extent almost inconceivable, without doubt were intended for some such purposes as those to which I have referred. I find that so early as 1415, a celebrated goldsmith, Sir Drugo Barentine, who was Lord Mayor of London in 1398, and again in 1408, gave "faire lands" to this Company. At the present day, when so much public attention is being devoted to the spread of technical education, it behoves us to see that the young goldsmith and jeweller is not neglected.

PREFACE OF THE FIFTH EDITION.

SINCE the publication of the last edition of this work, our knowledge of the sources of many Precious Stones, especially of the Ruby and Sapphire, has been very largely extended. The famous Ruby districts of Upper Burma, closed for ages to the Western World, have been thrown open to commercial enterprise and scientific investigation. This important subject will be found to be discussed in the following pages with a fulness not obtainable elsewhere; much of the matter in the chapters on the Ruby Mines of Burma having never been previously made public.

Nor are the Burma Rubies the only gem-stones about which our knowledge has been recently enlarged. Discoveries of Sapphires and Rubies have been made in certain parts of Siam, and Cashmere has come to be recognised as Sapphire-producing country. On these subjects the latest available information will be found in the present edition; whilst in connection with many other Precious Stones much additional and original matter has been added wherever necessary. A description of the Sapphire Mines of Montana has been written since my visit to the locality last December.

Stimulated by the marked encouragement which my labours had previously received, I have endeavoured to make the volume in its present form still more worthy of its popularity; and with this view, have subjected the entire work to a searching revision.

The early editions of this work contained a chapter on "Celebrated Diamonds," but that portion has been omitted in recent issues, in consequence of my having written a special work on the subject. In 1882 I published a volume of some 320 pages under the title of "The Great Diamonds of the World; their History and Romance." This work, which was most favourably received by the press, is now out of print.

In the earlier editions of my "Precious Stones" there was also a chapter on "Pearls." Some years ago I was induced to send my two sons on a visit to the various Pearl fisheries of the world. The information which I received from them was of so interesting a character, that my attention was forcibly directed to the entire subject of Pearls, and I soon accumulated far too much matter for introduction into a general volume on Precious Stones. Under these circumstances I set myself the task of writing a separate work, devoted entirely to Pearls. This appeared in 1886, under the title of "Pearls and Pearling Life;" and was so well received as to be at present out of print.

Notwithstanding the omission of any notice of Great Diamonds or of Pearls, it will be found that the bulk of the present edition of this work exceeds that of any of the preceding editions, a sufficient proof of the quantity of new matter which has been introduced in connexion with other subjects.

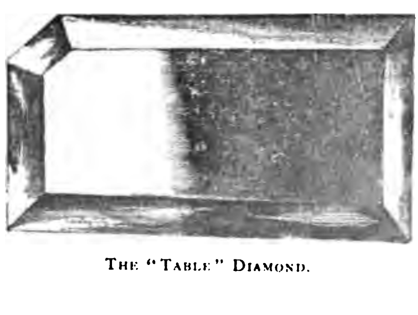
With these additions and improvements, the present edition is sent forth in the conscientious belief that it

contains an amount of infoimation on Precious Stones—partly scientific and partly practical—not to be found in any other work in the English language.

I cannot close this preface without acknowledging my obligations to Mr. W. S. Lockhart for his valuable description of the Ruby mines of Burma (pp. 168 to 176) and to Mr. E. B. Floyer for his interesting account of the ancient Emerald Mines of Egypt (pp. 222 to 226). I am also pleased to acknowledge the aid which I have received from Mr. F. W. Rudler, Curator of the Museum of Practical Geology, in Jermyn Street, whose mineralogical knowledge has always been cheerfully placed at my service when difficulties of a scientific character have arisen.

Edwin W. Streeter

Bond Street, London,
February, 1892.



The "Table" Diamond.

SECTION I.

PRECIOUS STONES IN GENERAL.

CHAPTER I.

DEFINITION OF THE TERM PRECIOUS STONE OR GEM.

AMONG the infinitely diversified products of Inorganic Nature, there are certain mineral substances which form a small class by themselves—standing apart from all others by the possession of such exceptional characters that they have always attracted the attention of persons endowed with taste and refinement. These minerals—the very aristocracy of the Inorganic World—are distinguished as *Precious Stones.*

The characters which have commended these stones in all ages, for purposes of personal ornament, are chiefly their brilliancy and colour, their durability and rarity. It is not sufficient, however, that a stone should possess only one of these characteristics. The mineralogist is familiar

with many stones that are exquisite in colour, yet far too soft to be used for the practical purpose of decoration ; on the other hand, there may be stones of exceeding hardness and durability, yet destitute of any beauty of colour or lustre, and therefore unfitted for personal adornment. Colour alone is by no means a necessary property in a precious stone: the diamond, for example, though presenting in some of its varieties every known tint, may be absolutely destitute of colour; nevertheless, it possesses the power of breaking up the rays of light which fall upon it, or pass into its substance, into rainbow-like tints of transcendent beauty. The perfect diamond, in fact, unites the properties of the most opposite elements—combining the purity of *water* with the flash of *fire.*

Precious Stones are frequently known also as *Gems.* It should be borne in mind, however, that this term is sometimes restricted by collectors of works of art to engraved stones—that is, to *camei* and *intagli*, especially those which have come down to us from classical antiquity or from mediæval times. It may, therefore, be convenient, in order to avoid confusion, to refer to the precious minerals themselves as *Gem-stones* rather than as Gems.

It is difficult to arrange the various Precious Stones in the order of their relative value, that order being subject to occasional variation according to the caprice of fashion or the rarity of the stones. Nevertheless it is believed that the following scheme, in which all Precious Stones are grouped in five classes, fairly indicates the relative rank which they take at the present day.

I. The Pearl stands pre-eminent. It is true that this substance, being the product of a mollusc or shell-fish, is not strictly a mineral. It is, however, so intimately related in many ways with the family of true Precious

Stones that it properly claims a place in any classification such as that under discussion.

II. In the second class, and therefore at the head of the group of Precious Stones proper, stands beyond all doubt the Ruby.

III. Then comes the Diamond. Many readers may be surprised to find the Diamond taking so subordinate a rank; but the time has gone by when this stone could claim a supreme position in the market. At the present day the Jagersfontein Mine, in South Africa, produces Diamonds of pure water rivalling the finest stones that were ever brought to light from the mines of India or of Brazil.

IV. In the fourth class comes first the Emerald, then the Sapphire, next the Oriental Cat's Eye, and afterwards the Precious Opal.

V. In the fifth class may be placed such stones as the Alexandrite, the Jacinth, the Oriental Onyx, the Peridot, the Topaz, and the Zircon. Some of these, especially the Alexandrite, are so beautiful that they deserve a more extended use in the arts of jewelry than they enjoy at present.

After these stones comes another class, which may be called the group of *Semi-precious Stones*. Many of these either lack transparency, or possess it in only very limited degree; while those which are pellucid are too common to command more than a trivial value. Such stones are frequently used for inlaid work, or similar ornamental purposes, rather than for personal decoration. As examples of such stones may be cited the Agate, Malachite and Rock-crystal.

That branch of Mineralogy which deals with Precious Stones is known in Germany under the special name of

Edelsteinkunde. But neither in this country nor in France does it possess any distinctive title. Perhaps it may be best designated in English as "The Science of Jewelry." So far from being a trivial or frivolous study, the Science of Jewelry implies a knowledge of all the properties and peculiarities of Precious Stones, such as their physical and chemical properties; the relation they bear to other minerals; their shape and structure; their defects and impurities. This science must, therefore include a competent knowledge of Crystallography, Physics. Chemistry, and Geology. Such knowledge in its entirety cannot be expected to be found outside the laboratory or the cabinet of the mineralogist. There are, however, several comparatively simple means of great value for the identification of Precious Stones, and as these admit of application without any profound knowledge of mineralogy they are given in an Appendix to the present work.

CHAPTER II.

WHERE PRECIOUS STONES ARE FOUND.

IT is a familiar fact that Organic Nature does not present an equal development of life in every part of the world. Each country—or at least each zone of climate—has its own fauna and flora—its peculiar assemblage of animals and plants. No one needs to be reminded that the animals and plants of the tropics are widely different from those of temperate zones, while these again differ from those of the Polar regions. But when we turn to the *Inorganic* world, we fail to detect any similar laws of distribution. Climate, so far as we know, is without sensible effect on the development of minerals and rocks. Many minerals are common to the hottest and the coldest parts of the world; yet they present no discernible difference whether brought from tropical or from Polar regions. It is true that occasionally there are slight local differences in crystallization, or in other physical characters, sufficient to enable an experienced mineralogist to say at once from what district a given mineral has been obtained. But these trivial differences are due rather to geological than to geographical conditions; and the assertion may be confidently repeated

that climatic influences have nothing whatever to do with the distribution of minerals.

Nor is this general rule in any way broken by those exceptional minerals which we distinguish as Precious Stones. It was a pardonable supposition of ancient writers on gems that these beautiful productions of the mineral world should be mainly confined to tropical countries. What more natural than the conjecture that those favoured regions which gave birth to gaily-coloured birds and gorgeous butterflies and flowers of surpassing loveliness should also produce minerals of the rarest brilliancy and beauty! Yet such a supposition is purely fanciful.

Precious Stones, in truth, are not confined to definite geographical limits or to particular climates, but occur abundantly and in about equal perfection in all latitudes. Nor do the gem stones of one country necessarily differ from those of other parts of the world. The Diamonds of India, for example, are hardly, if at all, to be distinguished, when polished, from those found in the Ural mountains, or in Brazil, or at the Jagersfontein Mine in South Africa. The Emerald of New Granada, again, is much the same as that which is found in Upper Egypt or at Katharinenburg, in the Urals. The Beryl of Siberia has proved no unequal rival to that of Brazil, and the Amethysts of the Bavarian Palatinate equal those found in the most favoured spots of South America.

It is not, indeed, the geographical position which determines the difference between the relative values of the sites; nevertheless it is an acknowledged fact that in India, Burma, Ceylon, and Brazil, and of late years in South Africa, in Siam, and in some of the Western States of America, larger gems and a greater abundance of them have been

discovered than elsewhere. Australia may, some day, prove a formidable rival to these localities.

The Ancients were wont to ascribe the pre-eminence of certain regions to evaporation from the earth in which the Precious Stones are found—an evaporation obviously more intense in tropical countries. It was a supposition pardonably fanciful, that the sunburnt tropics were more favourable to the blossoms of the inorganic world, than the dark skies of the north.

But although modern researches have shewn that Precious Stones are not limited to any defined geographical area, their distribution is yet in a measure circumscribed, inasmuch as they are not met with in all mountain ranges, nor in all geological formations. The most valuable are found in such ranges as are composed of rocks considered to be among the most ancient in the world—in rocks composed of granite, gneiss, porphyry, mica-schist, and calcspar. Sometimes they occur imbedded in the mass of the rock; at other times, protruding, as it were, from the surface and jutting forth into free cavities. When they are thus found in the very rocks where they were originally formed they are said to be in their *primitive* bed.

Many however, are found far from their primal home, in a *derivative* or secondary deposit, in diluvial or alluvial soils, in the gravels and sands of river-beds. This last mode of occurrence is perhaps the most frequent for the finer Precious Stones. Far removed from their native home by the force of heavy rains and rushing torrents, they have been loosened and carried onwards, rounded by friction against the *débris* with which they have been accompanied in their course. It is a strange fact that those stones which have been washed in the currents are generally the finest. Possibly this may be explained by a process of natural

selection which has weeded out the faulty stones, and left only those that, by their superior hardness, could survive the rough usage to which they have been subjected. It is their hardness and density that have not only preserved them from destruction, but have enabled many to retain traces of their original crystalline form.

In Ceylon, India, Burma, Siam, Brazil, Australia, Montana, Siberia, and South Africa—from which countries the great majority of our Precious Stones are obtained—they commonly occur in these derivative beds; and it is interesting to notice how various kinds of Precious Stones are found in company in the same locality, forming as it were a noble society of Gems, rendered still more illustrious by their association with the noble metals—gold and platinum. It is noteworthy, however, that the majority of the South African diamonds are unearthed from a rock which is considered by some mineralogists to represent the matrix in which the stones have been developed.

The habitat, or native home of each Precious Stone, and the conditions under which it occurs, will be specially indicated in this work in the description of the individual gems.

CHAPTER III.

PRECIOUS STONES AND THEIR USES IN BYGONE TIMES.

HISTORY and tradition testify to the fact that Precious Stones were valued and preserved thousands of years ago. In India, where the most costly were chiefly found, this was especially the case. Other lands, it is true, possessed Precious Stones, and handed them down from generation to generation, but probably knew less of their true worth or nature. Their transparency and dazzling beauty, their hardness and crystalline forms, must naturally have always excited wonder, and induced men to treasure them as amulets, if not to use them as personal ornaments. We know that in the time of Solomon, the love of grace and luxury induced the rich to desire the possession of Precious Stones, and even to seek for them in foreign lands.

In Egypt, in ancient times, many semi-precious stones were worked as scarabæan gems ; and we learn from the Septuagint, and from Philo, that the robes of the High Priest were set with Precious Stones. It is often difficult, in reading an ancient author, to know precisely what stone he intends to indicate, and ordinary translations of technical words are by no means to be trusted. This

remark applies, for example, to the names of the stones of the breast-plate of the Jewish High Priest, as rendered in our Authorized Version. The names which the Hebrews gave to these stones indicate that they derived their knowledge of them from the Egyptians, who, in common with other ancient races, knew but little of what we understand by Mineralogy. As regards India, Strabo and Pliny tells us that gold and Precious Stones were used for personal adornment, and that drinking cups were formed of precious metals set with Emeralds, Beryl, and Rubies.

From the East the Phœnicians, in their universal traffic, exported costly stones as well as ivory, with Syrian purple and other stuffs, which were known as early as the Homeric period. The songs of Homer contain references to valuable bright stuffs and stones which served for ornaments, without mentioning their special names or qualities. For instance "The witch puts on her costly robe and brilliant earrings;" but their nature is not defined. Eurymachus gives to Penelope an exquisitely worked necklace of gold, ornamented with light amber, bright as the sun. Eurydamas also gives magnificent earrings, such as must have been worn by high-born ladies and princesses in Homeric times.

The precious Onyx and the Sapphire are mentioned by Job, with the Coral, Pearls, Rubies, and Topaz of Ethiopia; and the place in which some were found appears to have been known by that patriarch of Uz: "He putteth forth His hand upon the rock: He cutteth out rivers among the rocks, and His eye seeth every precious thing."

Six or seven hundred years before the Christian Era, the Greeks were acquainted with a multitude of Precious Stones, and the rulers in Greece and neighbouring lands wore ornamental and signet rings set with gems, such as

Ruby and Sapphire. The famous ring of Polycrates (died B.C. 522) was doubtless as valuable to him for its costly stones and workmanship, as for any hidden virtue which it is said to have possessed. Herodotus, and some later Greek authors, mention Theodorus of Samos, the first engraver of stones, as the maker of this notable signet.

In the beginning of the 5th century, B.C., we find among the Greeks, a didactic History of Precious Stones; which indicates that their knowledge of them was not superficial.

Onomacritus, a Priest and Founder of Hellenic mysteries, 500 years B.C., treated of Precious Stones and their mysterious power. Commencing with the bright transparent crystal, he says, "Whoso goes into the Temple with this in his hand may be quite sure of having his prayer granted; as the gods cannot withstand its power." Further, he states, that when this stone is laid upon dry wood, so that the sun's rays may shine upon it, there will soon be seen smoke, then fire, then a bright flame." This flame was known among the Ancients as *holy fire*, and they believed that no sacrifice was so acceptable to the gods as when offered through its agency. In like manner Onomacritus sang the praises and supernatural power of the Agate, the Topaz, the spring-green Jasper, Amber, Chrysolite, Coral and Opal.

The superstitions attached to these and other stones were not confined to the Ancients. Even in this enlightened age, Eugénie, the late Empress of France, would not wear a precious Opal because it was said to bring ill luck to the wearer. Queen Victoria, on the contrary, having no such superstition, presented each of her daughters, on her marriage, with a parure of Opals and Diamonds.

After the early Greek period the knowledge of

Precious Stones advanced. Herodotus must have had accurate acquaintance with many of them. He mentions, besides the Emerald in Polycrates' ring, signet rings, such as that of Darius; and speaks of the so called Emerald column in the Temple of Hercules at Tyre, which at night gave out a wonderful light. Plato mentions the Sard, Jasper, and Emerald. The Adamas, Amber, and Loadstone were not unknown to him; and he shows some knowledge of the origin of both common and Precious Stones, and of their natural forms.

It is certain that Aristotle had knowledge of a still larger number of Precious Stones, and that he was acquainted with some of their special properties. His scholar, Theophrastus, has left us a small work on this subject. The little treatise of Theophrastus, Περι τῶν Λιθῶν, was written before the year 300 B.C., and, notwithstanding its brevity, is of special interest as being the earliest Greek work devoted to Mineralogy which has come down to modern times. It is true there exists a curious Greek poem on Precious Stones, Λιθικά, by the pseudo Orpheus, but this is of very little value from a scientific point of view, and its date is a matter on which the opinion of scholars is divided.

But though we have no other early Greek treatises on minerals, we find references to Precious Stones occasionally interspersed through the pages of other writers. Diodorus mentions the Topaz found in the Serpent Island of the Arabian Sea, probably what we now call Chrysolite. Dionysius Periegetes refers to the clear and brilliant Diamond, the beautiful Asterios that glitters like a star, the Lychnis, with the colour of fire, the blue Beryl, the dull Jasper, the pure bluish and greenish Topaz, and the ovely Amethyst with its soft, purple sheen.

In the time of Alexander the Great, and still more so in the time of the luxurious Diadocheus, there was a great increase in the use of Precious Stones as articles of luxury. They were not only used for signet rings, but also in ornamenting many articles of use and luxury, being especially set round the feet and other parts of the drinking vessels and candelabra of the period.

After the Romans became possessed of the treasures of Asia and Africa, they probably gained a much fuller knowledge of Precious Stones. The elder Pliny must have been better informed than his predecessors as to the places where gems were found. From him also we gain most of our knowledge of the views of the Ancients as to Precious Stones. During this period the luxury of Rome in respect to Precious Stones was enormous. The Emperors adorned their robes with jewels of immense value. Paulina, the wife of Caligula, covered her dress entirely with Emeralds and Pearls of untold wealth. Pliny says "we drink out of a mass of gems, and our drinking vessels are formed of Emeralds." A little later they began to mount their sacred pictures in frames set round with gems. Constantine entered Rome in a chariot of gold, adorned with Precious Stones, which are described as having sent forth brilliant rays of light. In his time the royal crown was first set about with similar gems, a custom which has been continued to the present day.

Passing on to the Christian Era we find among writers upon Precious Stones, that Isidorus, Bishop of Seville, in the year 630 A.D., takes a prominent place. He classified gems according to their colour. In the eleventh century Marbodus, Bishop of Rennes, wrote a *Lapidarium*, or Latin poem on stones, of which a Norman-French version is also known. A century later brought forth a really scien-

tific treatise by Mohammed Ben Mansur—a work marked by great acumen, and evidently the result of an extensive acquaintance with the stones which he describes. Coming down to later times, attention may be specially directed to the treatise *De Gemmis et Lapidibus*, written in 1609 by a Dutch physician, Anselmus de Boot, whose name is better known in its Latinised form of Boethius.

Most of the old writers on Precious Stones occupied themselves to a large extent with the study of the occult virtues which they attributed to these substances.

The number of properties ascribed to Precious Stones in the time of Isidorus is wonderful. They were said to have the power of conferring upon their happy possessors a host of blessings—health, beauty, riches, honour, good fortune, and influence. No wonder that men and women carried them about their persons, prizing them as amulets!

Precious Stones were also supposed to have some connection with the planets and the seasons. A special gem was worn for each *month*: thus—

In January	The Hyacinth.
„ February	„ Amethyst.
„ March	„ Jasper.
„ April	„ Sapphire.
„ May	„ Agate.
„ June	„ Emerald.
„ July	„ Onyx.
„ August	„ Carnelian.
„ September	„ Chrysolite.
„ October	„ Beryl.
„ November	„ Topaz.
„ December	„ Ruby.

The Twelve Apostles, also, were represented in mediæval times by gems, called *Apostle-stones*, viz.:—

1.—The hard and solid *Jasper*, representing the rock of the Church, was the emblem of *Peter*.

2—The bright-blue *Sapphire* was emblematic of the heavenly faith of *Andrew*.

3—The *Emerald*, of the pure and gentle *John*.

4—The white *Chalcedony*, of the living *James*.

5—The friendly *Sardonyx*, of *Philip*.

6—The red *Carnelian*, of the martyr *Bartholomew*.

7—The *Chrysolite*, pure as sunlight, of *Mathias*.

8—The indefinite *Beryl*, of the doubting *Thomas*.

9—The *Topaz*, of the delicate *James the younger*.

10—The *Chrysoprase*, of the serene and trustful *Thaddeus*.

11—The *Amethyst*, of *Matthew the Apostle*.

12—The pink *Hyacinth* of the sweet-tempered *Simeon* of Cana.

An Alphabet has been formed of the initials of Precious and Semi-precious Stones and is still in use to some extent at the present day. The nature of this alphabet is exemplified by the following table:—

	Transparent.	*Opaque.*
A.	Amethyst,	Agate,
	Almandine,	or Avanturine.
	or Amber	
B.	Beryl.	Bloodstone.
C.	Chrysoberyl,	Cacholong,
	Carbuncle,	Carnelian,
	Cairngorn,	Chrysoprase,
	Cinnamon Stone,	or Cat's Eye.
	or Cymophane.	
D.	Diamond.	Diaspore.
E.	Emerald.	Egyptian Pebble.
F.	Felspar.	Firestone.
G.	Garnet.	Granite.

H.	Hyacinth	Heliotrope.
	or Hiddenite.	
I.	Idocrase,	Jasper
	Iolite	or Jet.
	or Jargoon.	
K.	Kyanite.	Krokidolite.
L.	Lynx-sapphire.	Lapis-lazuli
		or Labradorite.
M.	Moonstone	Malachite
	or Moroxite	or Marcasite
N.	Natrolite.	Nephrite.
O.	Opal.	Onyx
		or Obsidian.
P.	Pyrope	Porphyry
	or Peridot	or Plasma.
Q.	Quartz.	Quartz-agate.
R.	Ruby.	Rose-quartz.
S.	Sapphire,	Sard
	Spinel	or Sardonyx.
	or Sphene.	
T.	Topaz	Turquoise.
	or Tourmaline.	
U.	Uranite.	Ultra-marine
V.	Vesuvianite.	Verd-antique.
W.	Water-sapphire.	Wood-opal.
X.	Xanthite.	Xylotile.
Z.	Zircon.	Zurlite.

If, for instance, it were required to represent the word *Alice* in a ring, the Jeweller might choose Amethyst, Lynx-sapphire, Idocrase, Chrysoberyl and Emerald ; or any other group of stones whose initial letters spell the name

It would be wrong to close this chapter on the

history of Precious Stones in Antiquity without reference to the erudite writings of the late Rev. C. W. King, of Cambridge, who devoted much of his life to this study, and whose works attest alike his classical scholarship, his refined taste and his love for engraved gemstones.

CHAPTER IV.

THE WORKING OF PRECIOUS STONES.

ALTHOUGH Professor Ruskin, in an eloquent lecture delivered some years ago at the London Institution, advised the ladies to wear uncut Precious Stones, it may be safely said that the eccentric advice of the learned professor will never be followed, either by the public at large, or by those connoisseurs who appreciate the true beauty of a noble mineral. It is true that the qualities for which Precious Stones are most prized,—their lustre, transparency, refraction, and dispersion of light,—may be to some extent visible even in their rough state; but in order to enhance these advantages, and to render them more attractive to lovers of beauty, the diamond must be subjected to cleaving, bruting, cutting, and polishing, while coloured stones must in like manner be submitted to the art of the skilful lapidary.

The cleaving, bruting, cutting, and polishing appertain to the art of the diamond-cutter, whose aim is so to manipulate the rough stone, as to produce with the least possible loss of weight, a regular, or symmetrical form, bounded by smooth, brilliant surfaces, called *facets*. The

subsequent cutting of designs or mottoes in the polished stone belongs to the art of the stone engraver.

It does not appear that the Ancients appreciated the art of the lapidary as highly as we do. They preferred weight to brilliancy, and size to effectiveness. They would have been horrified to sacrifice eighty carats of a stone weighing 186 carats—as was done in the case of the Koh-i-nûr—merely to enhance its effectiveness as a gem. To-day, on the contrary we should be satisfied with a stone of eighty-six carats, if by losing the 100 we could obtain a perfect gem. Accordingly, we see that the ancient lapidaries were generally content to rub down the angles, polish the surfaces, and retain to a great extent, the natural shape each stone possessed when discovered.

The clasp of the regal mantle of Charlemagne, in the French National Collection, is set with Diamonds which have the natural planes of the octahedron only partially polished. In the year 1290 there was formed in Paris, a guild of gem-polishers and cutters, and in 1373 the art of diamond polishing was practised in Nuremberg; the mode of procedure is, however, unknown to us. It was not till a subsequent date, that the famed "table-cutters" of Nuremberg formed themselves, in conjunction with the stone-engravers, into a regular guild. One of their rules was that apprentices to the lapidary's and engraver's art, should be bound to serve for five or six years, under the pretext of the great difficulty and responsibility of their mystery, before they might venture to set up in business for themselves.

On Church ornaments of unascertained periods, but undoubtedly of great antiquity, Diamonds have been found having upper table-like surfaces with four polished borders, and the lower sides cut as four-sided prisms or pyramids.

In the inventory of the jewels of Louis, Duke of Anjou, exhibited in the years 1360—1368, the following cut Diamonds are mentioned :—(1) a Diamond, of a shield shape, from a reliquary; (2) two small Diamonds, from the same reliquary, with three flat-cut, four-cornered facets on both sides; (3) a small Diamond in the form of a round mirror, set in a salt-cellar; (4) a thick Diamond, with four facets; (5) a Diamond, in the form of a lozenge; (6) an eight-sided, and (7) a six-sided plain Diamond.

In the beginning of the fifteenth century, there are found traces of the art of Diamond-polishing in Paris, and there still exists in that capital a cross-way called La Courarie, where the diamond-workers resided more than two hundred and fifty years ago.

In 1407, diamond-cutting made great strides under Hermann, an able artist. The Duke of Burgundy gave a magnificent dinner at the Louvre to the King of France and his Court, and the noble guests received eleven Diamonds set in gold. These gems were but imperfectly cut, yet with the intention and desire of heightening the play of light, and thus rendering the gift more gratifying to the guests they were intended to honor.

In 1434 Guttenberg learnt gem-cutting and polishing of Andreas Drytzehen of Strasbourg. It is known, too, that in the year 1590, a Frenchman, Claudius de la Croix, went to Nuremberg, and carried on the cutting of Rose garnets.

It was in Bruges, in 1456, that Louis de Berquem who had lived long in Paris, made known his famous discovery of a mode of cutting the Diamond into regular facets. This increased the play of light considerably, and wrought so thorough a revolution in the jeweller's art, that his contemporaries regarded him as the father of Diamond-

polishing and cutting. Just ten years afterwards, a guild of diamond-cutters and lapidaries was established in Bruges.

In 1475, Louis de Berquem made his first experiment with the object of obtaining *the perfect cut*, on three rough Diamonds of extraordinary dimensions, sent to him by Charles the Bold, Duke of Burgundy.

No. 1., historically known as the "Beau Sancy," was a thick stone, cut all over with facets. The author has had this stone examined and many models of it taken, and his impression is that the stone, commonly called the "Beau Sancy" is the work of an Indian lapidary.

No. 2 passed into the hands of Pope Sixtus IV.

No. 3, a badly proportioned stone, shaped as a triangle, was set in a ring, which, as a symbol of constancy, represented two hands clasped. Strange to say, it fell into the hands of that most faithless and inconstant of kings, Louis XI. It was presented to him by the Duke of Burgundy. Robert de Berquem relates that his grandfather, Louis, received from Charles the Bold 3000 ducats for his work.

Of Louis' pupils, many went to Antwerp, some to Amsterdam, and others to Paris. In the last named city the art of diamond cutting did not flourish at once, owing possibly to want of encouragement and to lack of raw material. It made some progress, however, under the powerful influence of Cardinal Mazarin, who ordered twelve of the thickest Diamonds of the French crown to be re-cut, and thenceforward they received the name of "the twelve Mazarins." No one knows what ultimately became of these costly stones. In the inventory of the French Crown Jewels, in 1774, there is only one, with the number 349, to which the name "tenth Mazarin" is given.

This was a four-cornered Brilliant, with somewhat obtuse angles, of pure water, weighing sixteen carats, and valued at £2000.

Owing to the patronage of the Cardinal, and the taste for Diamonds which prevailed among the higher classes in France, the art prospered in the seventeenth century.

Towards the end of the same century, Vincenzio Bruzzi, of Venice, experimented on coloured Diamonds, with the view of extracting the colour and leaving the Diamond white. This art is practised to some extent even at the present day, but with little success, as the colour always returns after a greater or less interval. De Boot, who wrote in 1609, asserts that his patron, the Emperor Rudolph II., had obtained, by the distillation of antimony, a secret preparation with which he was enabled to remove not only the colour but the flaws of imperfect Diamonds.

About the close of the seventeenth century, Paris possessed seventy-five diamond cutters in full work, and amongst them not a few very clever masters. One Jarlet cut a Diamond for the Russian Crown, of 90 carats weight. The prospect which seemed now to promise great things for the diamond cutters at Paris was, however, but short-lived; it soon became overclouded, and before the end of the century, the trade was well-nigh extinct. In 1775 there were only seven masters left in that city, and these gained but a scanty and precarious living. The re-cutting of old Diamonds was a thing of the past, and there were over 3832 carats of rough stones waiting to be cut. In consequence of the political troubles and the social disorder which closed in blood at this memorable epoch, the Diamonds had to be sent from Paris to be cut in Antwerp.

London has always had lapidaries and diamond cutters of great ability, and the "Old English cutting" (so termed

in the trade), is looked upon as the type of the best workmanship; yet, as the competition of skilled hands in Holland vastly exceeds that in England, the labour is less expensive and the art is more cultivated there than here. The English lapidaries are unrivalled in the cutting of coloured stones, but in the case of Diamonds, we must yield the palm to the Dutch. Of late years, however, the art of diamond cutting has been revived here with much success.

About a hundred and fifty years ago, London was the chief centre of the diamond-cutting trade; but the art was neglected until some twenty years back, when the great influx of Cape Diamonds led to its revival. The workmen were at first Dutchmen, but they were gradually displaced by Englishmen; and at present a Diamond may be cut in Clerkenwell almost as skilfully as at Amsterdam.

When Portugal was at the height of her power, a very extensive trade in Precious Stones was carried on in that country by the Jews, and the lapidaries of Lisbon, who were Jews, then carried their art to a state of perfection never, perhaps, surpassed; many of the old Lisbon-cut gems exhibiting a beauty of workmanship that taxes all the skill of our first lapidaries to rival. But the lapidary and merchant, however wealthy, were powerless to hold their own against religious fanaticism and bigotry, and the expulsion of the Jews from Portugal in the latter part of the sixteenth century, drove the lapidary and his art from Lisbon.

The exiled gem-merchants and lapidaries found an asylum in Holland, carrying their trade with them, in the same manner as the Huguenots brought silk weaving to England. Since that time Amsterdam has been one of the centres of the Diamond trade, and remains to the present day the principal seat of diamond-cutting. It is

said that out of 35,000 Jewish inhabitants of Amsterdam, about one-third are in some way or other connected with this business.

In India the stones are very imperfectly cut by the natives, often being quite irregular, and cut on one side only. The size and weight of the stones are valued there rather than the artistic cut. In workman's language the stones cut in India are "lumpy." This was the fault of the Koh-i-nûr, which was cut so clumsily by Hortensio Borgio, a Venetian, that it was reduced from 793 carats to about 186, and rendered as dull as a piece of rock crystal. It was re-cut in 1851 by Messrs. Coster, of Amsterdam, and reduced to about 106 carats. Unfortunately not very commendable judgment was shown in its re-cutting; and the stone still retains a vitreous lustre; a few extra carats' weight having been preserved at the expense of its beauty.

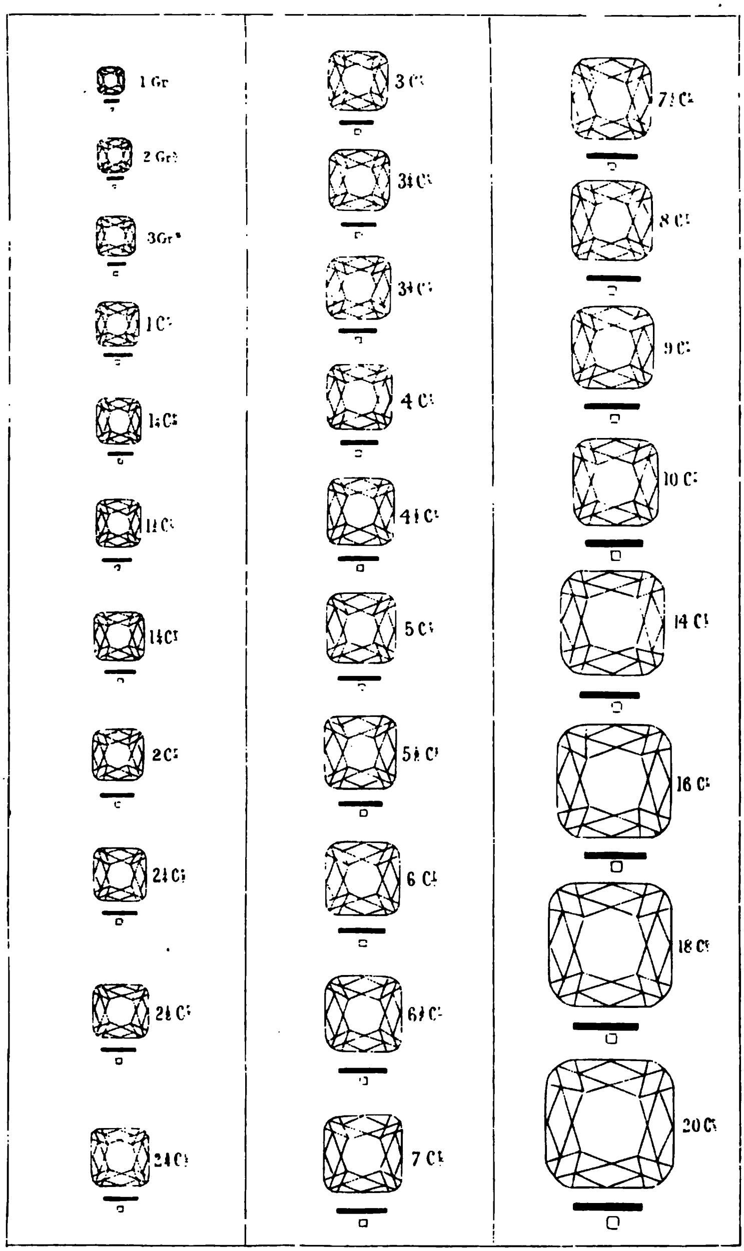
DIAMOND CUTTING.

The Diamond, the hardest of all known bodies, can only be manipulated by means of Diamond in the form of a fine powder. This powder is prepared generally from bort, or faulty Diamonds, and from the refuse in cleaving and cutting, which, being put into a mortar of hardened steel, is pounded until it is fine enough for use.

The cleaving or splitting of Diamonds serves a double purpose: firstly, that of removing faulty parts or black spots from the stone; and, secondly, that of bringing out the facets in rough.

Some Diamonds cannot be brought to perfection by grinding, without much labour, especially such as have very convex faces, and are nearly spherical. To obtain perfect

THE PROPER SIZES OF WELL PROPORTIONED BRILLIANTS OF THE VARIOUS WEIGHTS.



The Black Lines underneath show the relative thickness each Diamond should hav
and the round dots the size of the Culet.

facets in these by grinding on the mill would mean endless trouble. By splitting them, however, according to their natural cleavage, facets in the rough are obtained without much difficulty, and the pieces broken off are, as a rule, quite capable of being worked up as good diamonds. To avail himself of the cleavage, the workman must have an intimate acquaintance with the structure of the crystal. Diamonds can only be split along certain definite planes of cleavage, these planes being parallel to the faces of a regular octahedron.

There are three distinct operations in the cutting of Diamonds, namely, *splitting*, *cutting* and *polishing*. They form distinct branches of the trade.

The stone is first given to the *cleaver* or *splitter*, who examines it carefully in order to ascertain how he can develope or bring out every property to the best advantage with as little loss of weight as possible. It is his business to discover every imperfection. His tool is a wooden baton, having at one end a little projecting ferrule, containing a cement of brick-dust and resin. He makes this cement soft, by warming it at a small fire or lamp, lays the Diamond in it, and allows the stone to remain there until the whole is quite cold, by which time the Diamond is firmly embedded. He then takes another Diamond with sharp edges, and with it cuts a mark or notch in the one which he is about to cleave. This mark is generally in the shape of a V, and determines where the cleavage shall take place. So delicate an operation would be very difficult for an unpractised eye and hand. The workman catches every particle of dust in a box, having a sieve in it, which separates the dust of the cement from that of the Diamond. When the notch is made deep enough in the Diamond, the wooden baton is set upright in a block of lead. With one

hand the operator introduces the blunt edge of a little steel blade into the notch that he has made; with the other hand he strikes the blade a quick, sharp blow with a steel rod, and the stone is immediately split. This is always a serious operation, for if any want of skill were shown by the workman, the stone would be injured, perhaps irretrievably. The stone, now that it is divided, is taken out of the cement, and the process is repeated on another place; and so on again and again until the Diamond has received the rough form which the workman has decided upon.

The stone then goes to the *cutter*, who has similar instruments for his work. Instead, however, of cutting notches in the Diamond, he grinds two stones together until both are quite smooth, and thus brings out the facets which were roughly produced by the splitter. In grinding the stones, he has to be very careful that they do not become too hot. The process is very laborious, and the workman has to wear thick leather gloves to preserve his hands. From time to time the stones must be examined and the powder brushed from them with a fine camel-hair brush, and the facets touched with the tongue to keep them damp. The cutter gives the stone its definite form. If it is thick enough for a Brilliant, he forms the "table" first, and then successively all the facets. Everything depends upon the cutting of a Diamond. The table should be perfectly smooth, and without a ripple. It is important that the concentration of all the angles be so effected as to produce the greatest brilliancy.

The great home for Diamond cutting is still Amsterdam, although, in order to diminish the price of cutting, Germany and Switzerland have also been tried—especially the latter, Switzerland being the great home for female

labour; but the result has not been satisfactory, as will be seen by the following statement

A parcel of rough stones coming from the Cape was divided into three portions, one being sent to each of the above-named countries. The cost of labour in Germany was only *1s. 6d.* below that of Amsterdam, yet the stones lost so much by the cutting that their value was less by 10*s.*; and in like manner those of Switzerland, were 20*s* lower in value.

Only highly skilled and very honest artizans are entrusted with the cutting of large Diamonds. When the Diamond passes from the cutter's hands it is by no means perfect. The lustre and transparency for which it is so much valued are only fully developed in the hands of the polisher.

The polishing rooms of some of the great factories in Amsterdam, are well worthy of a visit.

The grinding and polishing of the Diamond are effected on flat wheels propelled by steam-power, which make about 2000 revolutions in a minute. Before these silently revolving discs you will see men so intent upon their work that they have eyes for nothing else; for, notwithstanding the perfection of the machinery, the skill of the workmen remains of primal importance. It is with their fingers and thumbs that they adjust the points, edges and facets of the Diamond with extreme accuracy, keeping them constantly moist with Diamond dust and olive oil. The thumbs of the workmen being used continually, and with much force, not unfrequently become enlarged.

The lapidary, who is occupied with the cutting and polishing of other precious stones than the Diamonds, or who is engaged simply upon semi-precious stones, arranges his work much in the same manner as the Diamond-cutter,

but he uses other means for the cutting and polishing, according to the nature of the stone to be worked. These special means will be noticed where necessary under the description of each particular stone.

THE FORMS OF PRECIOUS STONES.

The beauty of a cut or finished stone depends so much upon the form and position of its facets, that a moderately fine stone, well cut and polished, is of far greater value than a large one less artistically worked. It sometimes happens that the lapidary receives a stone of very unfortunate shape ; his duty will, therefore, be to take all possible care to preserve its size ; and, hiding its faults, give it such a form as shall send it forth with the greatest weight consistent with beauty and brilliancy.

In selecting Precious Stones you must mentally ask yourself the following questions : Is their transparency conspicuous ? Are they like dew-drops hanging from a damask rose leaf ; are they of pure water, and do they possess the power of refraction in a high degree ? Or, are they transparent and coloured ; and, if the latter, have they a play of colour ? Lastly, have they notable imperfections ?

Transparent stones must not be too thick ; for either they will refract light too strongly, or impede the light passing through, and thus rob the stone of its brilliancy and fire.

In colourless stones, the width and thickness which they must have are, as a rule, determinate ; whilst in colored ones they are regulated by the intensity and thoroughness of the colour.

The workman is compelled sometimes to give the

stone a form other than that intended by nature, in consequence of flaws and clefts, and in order to remedy irregularities in the stone. This is most frequently the case in large stones.

Different forms of cutting receive different names, which are often extended to the finished stone itself. For instance, if you hear of a " Brilliant " or " Rose " you know at once that the first is a Diamond with a table and culet, the second only a low pyramidal stone, facetted over the top, but with the under surface quite flat.

1.—*THE BRILLIANT.*

This is the most favourable form for enhancing the play of colour, and is therefore most effective for all Precious and most of the Semi-precious Stones. It is said to be the crowning invention in the art of diamond-cutting. It was due originally to Vincenzio Peruzzi, of Venice; a city which was, in his time, the chief seat of the Diamond trade.

As a Brilliant, the Diamond has almost the form of two cones united by their bases; the upper one being so truncated as to give a large plane surface at the top, while the lower one is much less truncated, and, in fact, terminates almost in a point. The stone being set with the broad plane uppermost, produces the effect of great depth of light, and its many facets increase what is termed its play of light; the density of the material naturally intensifying the refractive power, and thereby increasing its brilliancy. The plane surface at the top is called the *table;* the bottom plane is called the *culet* or *culette;* the junction of the upper truncated pyramid with the lower is the *girdle;* and the lower pointed portion the *pavilion.* Between the table and the girdle are thirty-two facets, and below the girdle

twenty-four. These facets receive their names from their forms. *Star* facets are those whose edges abut on the table; the others are generally triangular. According to the number of facets, the Brilliant is said to be single, double, or Old English cut. The Brilliant depends greatly upon the facetting for its exceeding beauty.

The English make the girdle rather sharp; while the Dutch make it broader. The former method brings out the play of light better.

A form, called the "Star," was invented by M. Caire, to take advantage of the clear portions of rough Diamonds, which could not be otherwise used without great sacrifice of material. This star-cut Diamond, as it is now worn, must be cut with extreme exactitude, avoiding the very slightest irregularity.

Briolettes are pear-shaped or oval stones, having neither table, culette, nor edge, but covered all round with triangular-shaped facets, and frequently pierced through at the top in order that they may be worn suspended.

2.—*THE ROSE.*

This form, which has been in use since 1520, but is now quite out of fashion, is fancifully supposed to resemble an opening rose-bud. It is chosen when the loss to the stone would be great if the brilliant cut were selected. The characteristic of the Rose is that it is flat below, and forms a hemisphere or low pyramid above, covered with small facets. These facets are in two rows: those in the upper row are called *star-facets;* those in the lower, *diagonal facets.* In the centre there are generally six facets of triangular shape. A circular stone is best for the Rose;

the facets being more effectively brought out, and more easily polished than in a flat-shaped stone

Although the Rose gives out a strong fire, and sends its rays as far as a Brilliant, yet, in the latter, the play of light is more remarkable, because the stone is deeper and the facets exactly correspond, thus making the prismatic colors more distinct.

The number of facets, together with their position, decides the name of the Rose. A *Dutch Rose* is constituted of twenty-four facets ; the *Rose Recoupée* of thirty-six ; and the *Brabant Rose* of twelve or even fewer, only less raised than the Dutch.

3.—*INDIAN CUT.*

This has an upper part, lower part, and girdle. Its most frequent form is that of a single-cut Brilliant. In consequence of the small effect produced by this form it is generally re-cut to meet European requirements, but this operation is usually attended with a very great loss of weight to the stone ; the natives always cutting the Stone for weight and not for brilliancy.

4.—*POINT CUT.*

Stones may be pointed naturally or artificially. Some Precious Stones may either be cut as four-sided pyramids, or are so formed by polishing the faces of the octahedron, and making them exactly true and regular. This style of cutting is found in antique ornaments only, and was well-known to Kentmann in 1562.

5.—*PORTRAIT STONES.*

These consist of thin plates of Diamond, evenly polished on both sides, with little facets on the edges. They serve to cover portraits in Jewelry.

6.—*STEP-CUT OR GRADUATED FORM.*

When the facets gradually decrease as they approach the table and *culasse*, the gem is designated a "Step-cut." The style is effective, especially in coloured stones, the light being thereby better reflected, and the play of color intensified.

7.—*CONVEX STONES OR CABOCHON.*

When a stone receives one or two convex faces with or without facets at the base, it is said to be *convex cut*, *e.g.* Almandine Garnet. But when its faces are simply polished, it is said to be cut *en cabochon*, as in the Opal and Cat's-eye. In ancient times the Sapphire was always so cut, and although sometimes the Emerald and Ruby are now so treated, the style is better adapted for stones of inferior value.

A stone cut with a flattish convex surface is said to be *tallow-topped*.

STONE ENGRAVING

Engraving Precious and Semi-Precious Stones is an art of unknown antiquity. The design is either sunk into the material below its surface, when the engraving is designated *Intaglio*, or it is in relief, being raised above the ground or surface, a process to which the term *Cameo* * is

* The Italian plurals of these words, namely *Intagli* and *Camei*, are used by precise writers, but the ordinary English plurals, *Intaglios* and *Cameos*, are more commonly employed.

applied. Nearly all kinds of stones and gems have been treated by one or other of these methods, although for obvious reasons, brittle gems are not ordinarily selected as materials upon which the art of the engraver can be satisfactorily exercised. Stones, transparent or opaque, and of one or many colours, spotted or striped, convex or even concave, have been chosen. As a rule, however, the master-works in this department of art are on beautiful transparent stones. An artist naturally does not care to expend his time and talent on a stone which will not display his work to the best advantage, and at its full worth. The stones preferred by the Ancients for engraving were the Emerald, Beryl, Hyacinth, Amethyst, Topaz, Lapis-Lazuli, Opal, and Chrysolite ; and among those of less value, the Carnelian, varieties of Jasper, Agate, Onyx, Sardonyx, Turquoise, Rock Crystal, Green Quartz or Prase, and Malachite.

There is a very beautiful specimen of a Turquoise-Cameo in the Vienna Collection ; and an Isis-head of the finest workmanship, in Malachite, in the Russian Collection of Jewels at St. Petersburg.

For Cameos it is desirable to select large stones, remarkable for beauty of colour, with different layers or strata ; although choice works of art have sometimes been elaborated on gems of only one colour.

The greater the number of layers that an Australian Opal or an Onyx or Sardonyx has, and the more beautiful and varied the colours which it presents, the more costly is the stone. The best stones for this particular work are those with a white layer on a dark ground. They are still better where there is a third layer above, such as white with a reddish or brownish tinge, which the artist can work into hair, wreaths, or dress. Entirely transparent Stones are very rarely used for Cameos.

Stone engraving seems to have been introduced into the West by Jews from Alexandria. In the Middle Ages, and even in later times, when there was no great master in the Art of Engraving, the cut stones of the ancient Greeks and Romans were used as signet rings. King Pepin sealed with the Indian Bacchus, and Charlemagne with a stone representing Jupiter Serapis.

Later on, signet rings were engraved with the king's signature; and lovers were wont to exchange at their betrothal, rings cut to represent wishes or allegories.

In the fifteenth century, when Constantinople fell under the dominion of the Turk, the Greek artists left their fatherland, carrying with them into Italy their secret knowledge of stone engraving. The first fruits of this immigration were seen during the Pontificates of Martin V. and Paul II. Lorenzo de' Medici assisted the development of the art by affording to Giovanni Bernardi the means of acquiring it both by instruction and by practice, so that he eventually received the cognomen of Giovanni delle Cornioli, in recognition of the perfection he had acquired in engraving Carnelian. His work was so exquisite that it bore favorable comparison with the masterpieces of old classic times, and he has been regarded as the restorer of the art of Stone Engraving in Italy. A contemporary of his, named Dominico de' Camei, employed himself in cutting beautiful Intaglios as well as Cameos. He sculptured on a pale red Ruby the likeness of Ludovico, the Moor, Duke of Milan.

Clement Birago, of Milan, or his master Trezzo, discovered in 1556 the art of engraving the Diamond. According to Blum, Ambrosius Caradossa was the first to sculpture Diamonds. It is stated that he engraved the figure of a Father of the Church, for Pope Julius II., in 1500.

The earliest trace of Stone Engraving in Germany is found in Nuremberg and Strasburg, in the 15th and 16th centuries. France, England and, in modern times, Rome have produced most excellent artists in Stone Engraving.

Modern artists have so well imitated the works of the Ancients that it is difficult for a practised eye to distinguish the old gems from the new, when they are copied from the originals. The Ancients possessed very able workers in Stone Engraving; but it would be unjust to modern artists to declare that all excellence in this department belongs to the antique, as the originals have not only been equalled but even surpassed.

Francis I., of France, made the first collection of engraved stones; and the Duke of Orleans' collection in Paris was of world-wide celebrity. Many of the most beautiful of ancient gems are carefully preserved in Berlin, and in Vienna, Naples, Florence, in the Barberini Palace, in the Museum of Duke Odescalchi in Rome, and in St. Petersburg and Copenhagen. The Blacas collection, in the British Museum, contains some of the most valuable "Gems," or engraved stones, in the world.

When true copies of these exquisite works of art are required, impressions can be made from them in various kinds of materials; such as plaster of Paris, and sulphur.

THE BURNING OF PRECIOUS STONES.

Precious Stones are often burnt or subjected to a high temperature, the heat exercising a very peculiar influence upon many stones, and in some cases modifying or utterly changing their colour.

Thus, the Oriental Carnelian owes its beautiful tint to artificial exposure to heat.

The Pink Brazilian Topaz too, derives its remarkable colour from burning.

One way of burning Precious Stones is to roll them up in a piece of sponge or tinder, and set fire to the enveloping material. Another method is to place them in a crucible, with either unslaked lime or iron-filings, and heat them until they are quite clear. Occasionally where a faulty stone with dark spots is burnt with sand and iron-filings, the spots are removed and the colour equalized; but the process requires great care.

Rubies are occasionally infected with white spots, which can be removed by burning. Many coloured Jargoons have their tints more or less completely discharged on exposure to a high temperature. Smoky Rock-Crystal also, carefully heated in a crucible with lime, sand, or charcoal, will usually come out perfectly clear. The discharge of colour is evidently due to the decomposition of the organic matter, with which the stone was tinted.

THE DYEING OF PRECIOUS STONES.

The possibility of giving artificial colours to Precious Stones was not unknown to the Romans. Pliny relates that recipes were offered for sale which professed to turn Rock-Crystals into Emeralds and other transparent gems; that in India many Precious Stones were produced by dyeing Rock-Crystal, and that the Ethiopians deposited the pale Carbuncle in vinegar for fourteen days, when it was alleged that it would shine brilliantly for a similar number of months.

Respecting the artificial colouring of certain Agates, Pliny says that in his day more of these stones were probably coloured artificially than naturally: and that in

Arabia the Agate-nodules, if cooked seven days and seven nights in honey, will, when prepared by the artist, present veins, stripes, and spots, which increase their effectiveness as ornaments.

This notion of honey purifying the Agate seems to be the foundation of the following beautiful idea: "All kinds of Precious Stones, cast into honey, become more brilliant thereby, each one according to its colour, and all persons become more acceptible in their vocation, when they join devotion with it: household cares are thereby rendered tranquil, the love of husband and wife more sincere, the service of the prince more faithful, and all kinds of business more easy and pleasant."—*Extract from the introduction to "The Devout Life," by S. Francis de Sales. Chap. III., par.* 13. 1708.

In Oberstein and Idar—two neighbouring localities near Kreuznach, on the river Nahe, famous for many centuries for the industry of working in Agate—the artists have been eminently successful in colouring not only the surface but the inner depths of a great variety of siliceous stones. The use of honey in the dyeing of stones was in early times the secret of a few Agate merchants at Idar, who obtained it from some Romans who periodically came to procure various kinds of Onyx from the stone-polishers at that place and at Oberstein. It is impossible to say whether these Romans acquired the knowledge by reading Pliny, or received it as a tradition in Italy.

The Art is based on the fact that the alternate layers of the Chalcedony, in the Agate Nodule are not equally porous, some strata readily absorbing a coloured liquid, while others imbibe little or none of it. The porosity of certain layers led the stone polishers to conclude that they might so color these as to render mean and insig-

nificant-looking stones suitable for Cameos and cognate purposes, and thereby materially increase their value.

The Agate merchants before purchasing a stone, test the worth of the raw stone for dyeing by striking a thin piece off it, damping it with the tongue, and observing whether the drying of the stripes takes place quickly or slowly. If the stripes absorb the moisture readily, the stone is good for dyeing, and especially for Onyx-dyeing. This test, however, cannot always be relied on, and the manipulators are sometimes obliged to colour a small piece experimentally before buying the stones.

At Oberstein and Idar the Onyx is dyed in the following manner. The stone is twice washed, and then dried. It is next laid in honey and water (half-a pound of honey to about sixteen or twenty ounces of water), or in sugar and water, or in oil. The dish in which it is laid must be clean. This is placed in a warm oven or on a stove, and care must be taken that the stone is always covered with the liquid, and that the liquid does not boil. This treatment is continued for a period of from fourteen to twenty-one days. The stone is then taken out of the honey, or other medium, washed, and placed in another dish with sulphuric acid. This dish is then covered, and placed in hot ashes with burning charcoal over the cover. During this process the acid is absorbed by the porous layers, and carbonizes the saccharine or oleaginous matter previously imbibed by the stone. In a very short time the stone will generally be dyed by means of the carbon deposited in its pores, which imparts to it a black or rich dark brown colour. Some stones require a longer time; and some will, despite all care, take no colour. The last step is to remove the stone from the sulphuric acid, wash it, dry it in the oven,

and lay it in oil for a day: this imparts to it an increased clearness and brilliancy.

The stone known as "Brazilian Carnelian" is worked in great quantities in Oberstein and Idar: the red colour is produced usually by steeping the stone in a solution of green copperas, or ferrous sulphate, and then exposing it to heat.

The method of imparting a blue colour to Agate was introduced at Oberstein in 1845. By steeping the stone first in a solution of yellow prussiate of potash and then in one of a ferric salt, a precipitate of Prussian blue is formed within the pores of the Agate. In other processes a solution of blue vitriol and ammonia is employed, so that an ammoniacal sulphate of copper, of magnificent colour, thus becomes the tinctorial agent.

Of late, exquisite blue dyes have been found for the Chalcedony, by which the varied shades of the more valuable Turquoise and *Lapis Lazuli* are produced. Both the English and French markets have plentiful supplies of these artificially-tinted stones, but the precise mode of operating in order to produce the finest tints is known but to a few.

A green colour, resembling that of Chrysoprase, may be obtained by impregnating the Agate with certain salts of nickel or of chromium; while a yellow tint is obtained by digestion in warm muriatic acid, the iron in the stone being thus converted into a chloride. In fact, the chemical resources of the German Agate-worker now enable him to colour a porous stone to almost any desired tint.

CHAPTER V.

PRECIOUS STONES AS OBJECTS OF COMMERCE.

THE trade in Precious Stones is considerably more important now than formerly. Before the discovery of America, India was the great emporium. Pegu, famous for its beautiful gems of all kinds, received yearly a very large sum for its exports; so also did Ceylon, from which island we even now obtain some few of our coloured Stones, especially Cats' Eyes and Sapphires, also Rubies of an inferior colour. It is only occasionally that fine stones are found there. During the dynasty of the Kandy Rulers, the right of digging for Precious Stones was most jealously guarded as a royal prerogative, and the inhabitants of particular villages, under the supervision of hereditary overseers, were occupied in the search for gems. Under the British Government this monopoly was given up, and traders needed no "special permit."

A number of men are constantly occupied in this exciting and precarious business: and the idle and disorderly adventurers who visit the villages are the

cause of great immorality among the inhabitants. The results of their labors they used to sell to the Malays who came to Saffragam with cloth and salt, which they exchanged for Precious Stones. At the yearly Bhudda Festival in August there is a jewel market held in Ratnapura, whither those interested in jewels flock from all parts of Ceylon.

The position of the people of Saffragam is so much improved of late years that they are able to retain for themselves any stones they find of great worth. Now and then they are induced to exchange them for Diamonds or gold, which they can equally well conceal. The artificers who cut and polish the stones on the spot are generally Malays. Their work was formerly very imperfect, and their knowledge of the Art faulty, but of late years they have much improved in the art of cutting gems. Stones of inferior value, such as Cinnamon-stone and Tourmaline, are cut and polished by ordinary workmen in Kandy, Matura and Galle, while artistic and experienced workmen who cut Sapphires, Cats' Eyes and Rubies, live chiefly in Caltura and Colombo.

As a general rule, the rare gems are cheaper in Europe than in Colombo. Precious Stones are brought from all parts of the world, both in the rough and native-cut to be re-cut by London lapidairies. In Ceylon the stock is so uncertain, that the price is largely determined at the moment by the rank and wealth of the buyers. The small Malay dealers do not purchase rare and fine jewels, knowing quite well that the best and finest specimens are carefully held back by the rich traders, or travellers, who consign them to England, or obtain from the native princes of India, who have an ardent passion

for gems, such remuneration as keeps up the prices of high-class jewels.

It is quite impossible to judge accurately by the Customs' Register in Ceylon of the worth of the Precious Stones which are sent out of the island. Only a small part is directly consigned to England; the remainder is bought up by private hands, but, for the most part, ultimately finds its way to the English market. It is calculated roughly, that the value of Precious Stones found in the island amounts to over £20,000 yearly.

More than a hundred and fifty years ago Brazil became a powerful rival of India for Diamonds. The most beautiful stones were found in the nearly inaccessible wilds of Minas-Geräes, by poor mulattoes and negroes, and sold to the merchants, but the working of these mines is no longer remunerative in consequence of the South African Mines.

While Brazil belonged to the Portuguese Crown, Lisbon enjoyed the largest share of the trade in Precious Stones. The trade was a prerogative of the Crown.

At the present day the remarkable development of Diamond-mining in South Africa, has almost driven the Brazilian Diamond out of the market.

In the trade of Precious Stones, the coloured stones stand far behind the Diamond; insomuch, that this stone alone represents about 90 per cent., and the others altogether only 10 per cent. of the quantity on sale.

Apart from the class to which the Precious Stone belongs, the price is determined by the beauty, the quality and play of colour, brilliancy, purity, rarity, the perfection of the cutting, and above all, the weight of the stone. This last quality increases the price considerably, as the most beautiful stones are generally found in only small crystals, and the value consequently rises in a high ratio with the size.

In the case of Semi-precious Stones, the size and colour also are much considered in determining the price, but these advantages are not so important as the artistic working of the stones. Stones depend mainly upon this adventitious circumstance for their actual worth. As a general maxim gems are valued for their rarity, freeness from flaws and quality; fashion occasionally exercising influence in a greater or less degree upon their market value.

At the Leipzig Easter Market, some years ago, Diamonds fell suddenly 50 per cent., owing to Dom Pedro having paid the interest of the Brazilian State-Debt to England in Diamonds instead of money, and thereby caused a glut in the market. In 1836 the price of Diamonds again rose. In 1848, in consequence of the Revolution in France, they fell greatly. From that year until 1865 the value of Diamonds seems to have increased at about the rate of 5 per cent. per annum. Then, at the end of the Civil War in America it sprang up suddenly 25 per cent. At the end of the Franco-German war of 1871 it rose another 10 per cent., and during the next two years there was a gradual rise amounting to 20 per cent. Afterwards, owing to the panic in America, and the effect of the discoveries at the Cape, the market price steadily fell; but, with the revival of trade, fine Diamonds again reached a very high value, and specimen Diamonds now realise a larger price than ever.

In buying Precious Stones much precaution is required. Few wares are liable to more faults and imitations than these, and the faults alone are sufficient materially to lessen their value. In the rough stones they are not easily observed; and in manipulated gems they may be hidden to a large extent by clever workmanship.

Among the most frequent defects are: (1) *Feathers:* little rents or fissures in the inside of the stone; found in all kinds of Precious Stones. (2) *Clouds*: grey, brown and white spots, very like clouds, which much increase the labour of preparing the gem for sale; this fault is mostly found in Diamonds and pale Rubies. (3) *Sand*: or little seed-like bodies within the stone, of white, brown or red colour: these are called *dust* when very fine and in large number in one stone. Absolute perfection is no more to be found in Diamonds and Precious Stones, than in any other created things; for, however perfect they may appear at first sight, there is, as a rule, some trifling defect discoverable on minute inspection. This is occasionally remedied by the stone being cleaved.

THE FIRST KNOWN APPLICATION OF DIAMONDS FOR ORNAMENT.

The adaptability of the Diamond for personal ornament is grounded mainly on its conspicuous lustre and beautiful play of light, properties which are rendered prominent by cutting the stone, so as to give it the greatest number of surfaces consistent with its size. By this manipulation the rough stone loses an amount of material tending in some cases to more than one-half, and someties as much as two-thirds of its original weight.

The Syrians seems to have been the first to apply the Diamond to personal ornament, although it was an article of commerce much earlier among the people of the East. They valued it highly, carried it as an amulet, and attributed to it many medical virtues. It was regarded also as a safeguard against madness.

Although Jeremiah (xvii. 1) speaks of the sin of Judah being written with "the point of a Diamond,"—*puncto adamantinis* of the Vulgate—it is probable that this *adamas* was the corundum, and not the true Diamond. Ezekiel says of the Syrians :—"Thou hast been in Eden, the Garden of God ; every precious stone was thy covering, the Topaz, and the Diamond, the Beryl, Sardius, the Onyx, and the Jasper, the Sapphire, the Emerald, and the Carbuncle. . . . Thou hast walked up and down in the midst of the stones of fire." (Ez. xxviii. 13, 14).

The Chaldeans—who were the most superstitious people, and seem to have initiated the Jews into their mysteries—and their charms against evil and mischance—perverted the precious stones from their purpose of ornament and even of usefulness into idolatrous amulets, and fixed on them superstitious attributes, from which it has been found impossible to dissociate them, even at the present day.

In early times the Diamond was worn *rough*, or polished only on its upper surface. It was in this form that it was used to ornament temples, state goblets, reliquaries, and crowns. In India the native uncut stones are still prized under the name of *Naifes.*

It was not until the time of Charles VII. that the French ladies began to adorn themselves with Diamonds. The well-known Agnes Sorrel was probably a leader of this fashion. Under Francis I. the ladies indulged to such an extent in Diamond ornaments that it gave rise to the saying, that "the ladies of France carried mills, forests, and lands, on their shoulders." The Luxus or Sumptuary Laws, in the reign of Charles IX. and Henry IV., were aimed at this extravagance.

After the introduction of the art of Diamond-cutting

by Louis de Berquem, Diamonds were largely used for ornament; and at the present day a lady's dress is not considered complete without them.

The original cut of the Diamond was that of the table-form, with a row of facets above. It was not until the year 1520 that the Rose-cut was introduced, whilst the form of the Brilliant was not known until the reign of Louis XIII. of France. It was Cardinal Mazarin in 1660 who first had the Diamond cut as a Brilliant.

The Diamond, in consequence of its supreme hardness, was formerly very rarely engraved: up to the time of Pliny it appears never to have been attempted. The art of engraving on Diamonds is said to have been invented by an Italian named Trezzo, who executed the arms of Charles V. upon a Diamond. His pupil, Clement Birago, engraved on another Diamond the portrait of the Spanish prince, Don Carlos; and the arms of Queen Mary of England are believed to have been executed on a Diamond by Jacobus Thronus. It is possible, however, that in some cases, White Sapphires and Topazes may have been mistaken for Diamonds.

Notwithstanding this doubt, there are certain engraved stones which are, unquestionably true Diamonds. Thus, the Duke of Bedford possesses a Diamond with the head of the philosopher Posidonius engraved on it; and although Kluge believes this to be an isolated example, yet there are others in existence. In 1877 one was offered for sale: it was a thin stone, the size of a fourpenny piece, engraved with the head of an emperor. The price was £1000; but at such a sum it did not find a ready purchaser. This stone was exhibited in the Paris Exhibition of 1867. In the late Hope collection there was a Diamond engraved with the head of Leopold II.

At the present day, the art of gem engraving has arrived at such perfection that Diamonds are engraved like any other gem-stones. No difficulty is made, if taken to the proper artist. Any design, pattern, or arms may be as easily engraved on Diamond as on any Coloured Gem.

SECTION II.

CHAPTER I.

THE DIAMOND.

THE crystalline forms in which the Diamond occurs in nature belong to the group of geometrical solids known to crystallographers as the *Cubic* or *Tesseral* or *Isometric* system. The most common forms are the octahedron and the rhombic dodecahedron; the former bounded by eight equilateral triangles, and the latter by twelve rhombs, or lozenge-shaped surfaces. One peculiarity of the crystallization of the Diamond is that the surfaces are often more or less curved, or convex, whilst those of other crystalline bodies, with few exceptions, are flat. Not unfrequently the diamond takes the form of a six-faced octahedron, which, by the rounding of its eight-and-forty faces becomes almost spherical or approaches a small ball in shape. In some cases the crystals are curiously "twinned."

Groups of crystals, dodecahedra as well as octahedra

are not rare; there is for instance, a very fine specimen of such a mass of coalesced octahedra in the Royal Mineral Museum at Dresden. In the Vienna Collection there is a Diamond which has, enclosed within itself, another similarly-crystallised Diamond of a yellow colour; and the author has lately observed a case in which on cleaving one from South Africa, a small diamond of almost black colour fell out from its enclosure. Various included bodies, mostly microscopic, have been recorded by Sir David Brewster, M. Chatrian and other observers.

The surface of a crystal of diamond is generally smooth; but it is sometimes indented with triangular impressions, and in certain cases is striated with lines parallel to the edges of the octahedral faces. Some diamonds present a rough surface, resembling a poorly polished glass, and are not unfrequently dull, as though covered with a thin coating of gum.

The Diamond is occasionally found in concretionary crystalline forms, which pass under the name of *Bort;* while another variety termed *Carbonado,* of brownish-black colour, is so indistinctly crystalline as often to be regarded as compact. These varieties will form the subject of a separate chapter.

The Diamond presents a perfect cleavage, parallel to the faces of the octahedron, which is its primary form. The Diamond cutter avails himself of his knowledge of this natural structure, and is thereby enabled in many cases to remove spots from a stone by cleaving, without resorting to the weary work of grinding. The famous Dr. Wollaston, in the early part of this century, was one of the first to call attention to the advantages offered by the ready cleavage of the Diamond. It is said that having purchased of Messrs. Rundle and Bridge a rough Diamond, which

they considered too much flawed to be worth cutting, the learned doctor minutely studied the structure of the stone, and having removed the defective part by cleavage had the perfect portion cut, and then re-sold it to Messrs. Rundle and Bridge at a very large profit. Long before Dr. Wollaston's time, however, there must have been many students of Precious Stones who were familiar with the cleavage of the Diamond. Thus De Boot, writing in 1609, tells us that he knew a physician who boasted that he could "divide a Diamond into small scales like a piece of talc." The fracture of the Diamond, apart from its cleavage, is conchoidal, and here and there the stone is liable to split off in fragments.

In addition to the property of cleavage, the Diamond possesses pre-eminently that of hardness; a quality in which it so exceeds all other bodies that it can penetrate them without being itself even scratched. In consequence of its excessive hardness it was formerly only possible to polish it partially, and hence it was the practice to use it in the form it presented in the rough. In early times there existed so exaggerated an idea of its extraordinary hardness that it was said a Diamond could not be broken by a hammer on an anvil, and that it was far easier to strike the anvil into the earth than to break the Diamond. This will account for the loss of many Diamonds in antiquity, as it was the absurd practice to place them upon the anvil to test their genuineness. Through this ignorance many a regal gem has no doubt been shattered and so lost to the world. It was only the brittleness of the stone which was really tested by the hammer, and not its hardness, which is a very different quality.

Pliny gives a detailed account of the Diamond in his "Natural History," xxxvii., 15. He says: "The most

valuable thing on earth is the Diamond, known only to kings, and to them imperfectly. . . . It is only engendered in the finest gold. . . . . Six different kinds are known. Among these the Indian and Arabian, of such indomitable, unspeakable hardness, that when laid on the anvil it gives the blow back in such force as to shiver the hammer and anvil to pieces. It can also resist fire, for it is incapable of being burnt. . . . This superiority over steel and fire is subdued by goat's blood, in which it must be soaked when the blood is fresh and warm; then only when the hammer is wielded with such force as to break both it and the anvil, will it yield. . . . Only a god could have communicated such a valuable secret to mankind. When at last it yields by means of the blood, it falls into such small pieces that they can scarcely be seen."

The curious opinions of the Ancients as to the infrangibility of the Diamond are discussed by Sir Thomas Brown, in his famous work on "Vulgar Errors," written in 1646. The doctor is naturally led to discard the old views, notwithstanding the support which they had received from the early Christian writers, and to conclude on the evidence of practical diamond-cutters that Diamonds "are so far from breaking hammers, that they submit unto pistillation, and resist not an ordinary pestle." As a matter of fact the Diamond is so brittle that it is readily reduced to grains, or powder, in a steel mortar.

Hardness is the best test of the genuineness of a Diamond. If a mineral cannot be scratched or cut by Ruby or Sapphire, it must be a Diamond. It is said that the officers of the "Junta Diamantina" in Brazil, test the genuineness of two rough Diamonds by rubbing them together close to the ear, when, if they be genuine, they

make a peculiar creaking or grating noise, which the long experience of the testers easily recognises.

It is notable that the hardness of the Diamond varies in different crystals, and the experience of Diamond-cutters leads to the conclusion that the Australian and Indian Diamonds, are, as a rule, slightly harder than the Borneo and Brazilian, while these again have usually a superior hardness to Cape stones.

Optical Properties.—Refraction.

The conditions which the Diamond presents in relation to light are very remarkable. It is one of those bodies which refract light most strongly—that is to say, when a ray of light enters a Diamond, it is turned from its original path to a much greater extent than if it had entered a Topaz, or a Rock-Crystal, or a piece of glass, or, in fact, any other transparent medium. Hence the magnifying power of a Diamond is much greater than that of glass. It is said that if a Diamond and a piece of plate-glass be ground into lenses of similar form, the magnifying power of the Diamond will exceed that of glass in the ratio of 8 to 3. It was this that induced Mr. A. Pritchard many years ago to apply the Diamond as a microscopic lens; but owing to the great difficulty of manipulating it, so as to adapt it to the purpose, as well as its intrinsic value, its use was extremely restricted.

As the diamond is found in nature as a crystalline solid substance, of distinct form, it has been generally assumed to be a mineral production. Probably the first philosopher to throw doubt on this conclusion was Sir Isaac Newton. In his remarkable optical researches he had established a definite relation between the refractive

power of a body and its density. The power of refraction in each body is expressed scientifically by a certain number, or numerical ratio, called the *index of refraction.* Now, Newton found that the index of refraction of Diamond was much higher than he should have anticipated from the specific gravity of the stone. But he had observed that fatty and resinous bodies—such as oils, turpentine, and amber—possessed in like manner a higher refractive index than their density would suggest. Hence he was led to throw out the bold conjecture that the Diamond might be "an unctuous body coagulated!"

The optical and other physical properties of the Diamond have led some of our greatest naturalists to the conclusion that, although it is certainly now a mineral substance, it was probably originally of vegetable origin—a conclusion of which the author, after a long and careful study, has no doubt.

Reflection and Dispersion.

In addition to its property of strong refraction, the Diamond possesses the power, in an extraordinary degree, of reflecting and dispersing the rays of light, thus causing what is technically termed the "play of colors," observable on a well-cut Diamond. The optical term "dispersion" is applied to the power which a transparent substance possesses of breaking up the incident white light into prismatic tints, like those of the rainbow—a power which is enjoyed to an unusual extent by the Diamond, and gives rise to the splendid flashes of fire emitted by a stone which has been skilfully cut.

As the value of a Diamond depends very materially upon this play of colors, many methods have been essayed

from time to time for testing it. Babinet recommended the following plan, which he himself was in the habit of employing. In a sheet of white paper he pierced a hole somewhat larger than the Diamond to be tested; he then let a ray of sun-light pass through the hole, and holding the Diamond a little distance from it, yet at such an angle as to allow the ray to alight on a point of a flat facet, he found this facet to be forthwith represented on the paper as a white figure, whilst all around little rainbow circles were delineated. If the observer found the primary colors, *i.e.* red, yellow, and blue, definitely separated one from the other in these little circles, and if their number were considerable, and they stood at equal distances from each other, then he pronounced the Brilliant to be well cut.

The effulgency of a good Brilliant largely depends on the fact that by the small "critical angle" of a Diamond, much of the light which enters the stone, instead of passing through it, is "totally reflected" from some of the facets, and thus returns to the eye of the observer. In the Rose Diamond the light is reflected from the under-plane, and produces a similar effect to that seen in the Brilliant.

The Diamond does not possess the power of double refraction, neither does it polarize light, as commonly understood, although according to Brewster, there are in some stones certain optical irregularities due to internal air-bubbles, or open cavities. The author has had one in his possession, which reflects different colors according to the direction in which the solar rays light upon it. Outside these air bubbles, light passes through, perfectly unpolarized: hence it seems fair to conclude that the mass was originally so soft, that the enclosed air could, by expansion, compress the part lying nearest to it, just as

similar results may be produced by pressure in glass and resin, Such compression on the mass close to the air bubbles, Brewster declared to be nowhere found among minerals produced by the operation of heat; and he concluded, therefore, that the softness which the Diamond, without doubt, formerly possessed was that of a half-dried gum. This deviation in refraction, due to internal strain, has given rise to the erroneous belief that the Diamond possesses true double refraction.

Lustre and Color.

The lustre of the Diamond is the peculiar, indescribable, but well-known *adamantine lustre.* The surface of the native crystal is often rough, and has a peculiar leaden-grey semi-metallic lustre.

The Diamond in its purest condition, is colourless and transparent; yet at times it is found coloured throughout of almost every possible tint; it may thus become pale-yellow, deep-yellow, light bottle-green, yellowish-green, blackish-green, blue, red, brown, and black. Yellowish tints are the most common in "off-coloured stones;" next to yellow, greenish Diamonds are most numerous Blue and red are very rare, and are highly valued as fancy stones. When the Diamond is between brown and black its transparency disappears, or is seen only at the angles.

Perfectly colourless Diamonds come from the mines of India, Brazil, the Cape, Borneo, and Australia. Perhaps about one-fourth of the crystals which come into the market are colourless; one-fourth of "pure water," with a flaw or spot of colour: and the remainder coloured.

The coloured Diamonds exhibit their lustre and clear-

ness best when they are cut, especially the yellow ones, which, by candle-light, are very brilliant.

Barbot, by means of chemical agents and a high temperature, is said to have succeeded in removing the colouring matter from the rough Diamond ; green, red, and yellow stones becoming perfectly colourless, while the dark yellow, brown, and black, gave up very little of their colour. It seems scarcely possible that this can be accurate, though M. Barbot on the title-page of one of his works styled himself "Inventeur du Procédé de Décoloration du Diamant brut." Curiously enough, De Boot asserted 280 years ago, that his Imperial patron, Rudolf II., possessed a secret which enabled him to clear any Diamond of its flaws and colour.

Various devices have been resorted to by unprincipled dealers for deceiving the purchaser in respect to the colour of Diamonds. Thus, the yellow tint of many off-coloured Cape Stones, has been corrected by painting them with a pale blue solution, or washing them with dilute violet ink. The effect is only temporary, and the trick is of course easily detected by placing the Diamond in spirit.

In many Diamonds the core is not pure, but shows blackish or greenish spots. This is more particularly the case in the green stones. Many Diamonds have also "feathers" and fissures, which materially modify the passage of light, and of course diminish the value of the stone.

Black Diamonds of great beauty are occasionally supplied by Borneo, which are so adamantine that ordinary Diamond-dust makes not the smallest impression upon them ; and they can only be ground or polished by using their own dust for the purpose. Borneo also yields Diamonds, of many other colours.

Phosphorescence, &c..

Phosphorescence is produced not only by heat, but also by the action of light, and persists long after subsequent isolation or removal from the luminous source The Diamond becomes phosphorescence under the influence of the sun's rays, and remains so for some time after removal from the sunshine, even when covered with cloth, leather, or paper. It appears that this property was first recorded by Boyle in the year 1663.

The phosphorescence is most striking after the Diamond has been exposed to the *blue* or more refrangible rays of the spectrum; under the red rays, or rays of low refrangibility it is much weaker. In an experiment of Barbot's, it is said the Diamond showed phosphorescence when he placed it under cover of limewood two millimetres (one twelfth of an inch) thick, after it had been removed from the influence of of the sun's rays.

The author on one occasion exposed a fine orange-colored Diamond of about 115 carats to the prolonged action of a powerful lime-light, and then removed it to a small dark-room, when the phosphorescence was sufficient to light up the apartment. All Diamonds do not phosphoresce after exposure to light, but diamonds of yellow colour seem peculiarly susceptible to luminous influences.

In Mr. Crookes's remarkable researches on radiant matter, he submitted the Diamond and other minerals to the effect of the molecular discharge in vacuum tubes connected with a powerful induction coil. "Without exception," he says, "the Diamond is the most sensitive substance I have yet met for ready and brilliant phosphorescence."

It has been shown by Mr. G. F. Kunz, of New York

that a very slight amount of friction is sufficient to cause a Diamond, if clean and dry, to exhibit a phosphorescent glow of greater or less intensity. The friction may be effected on either wood, cloth or metal; but the best results were obtained by rubbing the stone on wood, in a direction across the grain.

The Diamond is a non-conductor of electricity—a fact which is the more remarkable as Graphite and Charcoal, substances absolutely identical with it chemically, are very good conductors. By *friction*, however, both in the rough and polished state, it becomes positively electric, but loses its electricity completely in the course of half-an-hour. When exposed to the intense heat of the electric arc, the Diamond swells up, becomes black, and is converted superficially into a substance resembling Graphite.

Chemical Composition.

The chemical composition of the Diamond was not demonstrated completely until about forty-four years after Sir Isaac Newton's death (*b.* 1642—*d.* 1727). Notwithstanding the expressed conviction of Newton that the Diamond was combustible, a great contemporary, the Hon. Robert Boyle, desirous of putting the combustibility of the Diamond to the test, placed a Diamond in his crucible, and there subjected it to an intense heat without effecting his purpose. His death occurred in 1691, and three years afterwards the Grand Duke Cosmo III. induced the Academy of Cimento in Florence, to fix a Diamond in the focus of a large burning glass, and expose it to the solar beam: the experiment was performed by the Academicians Averani, and Targioni; and the experimentors saw the Diamond

crack, coruscate, and finally disappear, without leaving behind any appreciable ash. In 1750, the Emperor Francis I., in the presence of the celebrated chemist Darcet, in Vienna, subjected Diamonds and Rubies, of the estimated value of £600, to the heat of a smelting furnace for four-and-twenty hours, when the Diamonds wholly disappeared, but the Rubies remained, not only uninjured, but more lustrous than before. The author in like manner has exposed Burmese Rubies to very high temperatures, in order to see whether they might not be thus removed from their matrix of calcspar, without producing any appreciable effect upon them.

Many authorities in the, scientific world turned their attention during the last century to the chemistry of the Diamond, and carried on experiments, to ascertain the exact nature of its composition. In the laboratory of M. Macquer on July 26th, 1771, a magnificent Diamond was burnt with the same result as that which the Emperor Francis had obtained just twenty-one years previously in Vienna. The opinion of Robert Boyle, on the combustibility of the Diamond, appears to have received the assent of many chemists of high repute, and the incontestable fact that the crystal had in certain experiments disappeared, provoked the following puzzling questions. How had it vanished? Had it volatilized? Had it exploded? No. It had actually undergone combustion—a fate which has befallen several hundreds of small Diamonds burnt under the author's care by Professor Pepper. The experiments were performed in conjunction with him, both at the Royal Polytechnic Institution and at the author's establishment: in all cases the Diamond was practically consumed, leaving behind only an insignificant amount of ash in the form of a light bluish powder.

It appears that, notwithstanding the experiments in France which demonstrated the combustibility of the Diamond, a well-known jeweller of Paris, M. Leblanc came forward, and declared the Diamond to be indestructible in the furnace, though heat might be applied for any length of time. He stated in confirmation of his assertion, that he had often subjected Diamonds of his own to intense fire, to rid them of blemishes, and that they had never suffered the slightest injury from his treatment of them. Thereupon the two chemists, Darcet and Rouelle, demanded that he should make the experiment before them on the spot. He accepted the challenge, and taking some Diamonds, he enclosed them in a mass of charcoal and lime in a crucible, and submitted them to the action of the fire, expressing himself confident that at the end of the trial he should find them uninjured. But alas! he had sacrificed his Diamonds, for on looking into the crucible after the three hours' trial, they had entirely disappeared. His colleagues, however, did not long enjoy their triumph, for M. Mitouard, another jeweller, in the presence of the eminent chemist, M. Lavoisier took three Diamonds, and having *closely packed them in powdered charcoal*, in an earthen pipe-bowl, submitted them to the test of fire, and when the bowl was removed and cooled, there lay the Diamonds in the centre of the powdered charcoal, untouched by the heat. Lavoisier was not convinced by the experiment, and it soon occurred to him that the conditions under which M. Mitouard's test was conducted might account for the difference of result. It was, indeed, soon discovered that the immunity enjoyed by the Diamonds of M. Mitouard, was due to the exclusion of the oxygen of the air from the Diamond by packing it in a substance of the same nature in a state

of fine division, by which means all the oxygen that was admitted attacked first the carbon with which it combined. Lavoisier thus appears to have set the matter at rest; but it was not until 1816 that Sir Humphry Davy showed conclusively by quantitative experiments that the Diamond was practically nothing but pure carbon.

When a Diamond is burnt, with a free supply of oxygen or of atmospheric air, it is completely converted into the gaseous body known to chemists as *carbon-dioxide.* This carbon-dioxide, which is commonly called carbonic-acid, resulting from the burning of the Diamond is identical with that which attends the combustion of every fire and gas burner, or the decomposition of organic bodies, and which is exhaled in every breath we breathe.

The temperature must be very high and somewhat protracted for the burning of a solid Diamond. A much lower degree of temperature, however, will be sufficient to burn Diamond dust, if the latter be spread out on a thin red-hot platinum plate, placed over a spirit lamp. Small Diamonds will burn in a short time, if put on a plate of the same metal, and if the flame of a spirit-lamp be directed by a blow-pipe under the plate.

When a Diamond is subjected to the sun's rays in the focus of a burning glass, or heated in oxygen gas, it gives out bright red sparks while burning. In order to observe how the Diamond suffered during the process of combustion, Petzholdt took two sharp-angled pieces of Diamond. and placed them before the oxy-hydrogen blow-pipe. From time to time they were removed in order to observe the action of the fire upon their form and substance; he thus detected that the heat had first acted on the sharp angles, thus rounding the Diamonds; and on the

re-application of the heat, he observed that the Diamonds soon split up in pieces, and lost both their transparency and lustre. He could not detect any evidence of melting on the surface of the burning Diamonds; but on removing them from the fire, they assumed a leaden-grey color. Lavoisier also noticed that on exposing the Diamond to intense heat, black spots appeared on it, then disappeared, and re-appeared. Guyton de Morveau confirmed these statements. He consumed a Diamond in oxygen, by means of a burning-glass. First he saw on that corner of the Diamond which was in the exact focus of the lens a black point; then the Diamond became black and carbonized. A moment after, he saw clearly a bright spark, twinkling as it were on the dark ground; and when the light was intercepted, the Diamond was red, and for a time transparent. A cloud now passed over the sun, and the Diamond was more beautifully white than at first; but as the sun again shone forth in its full strength, the surface assumed a metallic lustre. Up to this point the Diamond had sensibly decreased in bulk not being more than a fourth of its original size; of elongated form, without definite angles, intensely white and beautifully transparent. The experiment was suspended for a day or two. On its resumption, the same phenomena recurred, but in a more marked degree; subsequently the Diamond entirely disappeared. At the conclusion of his treatise, in which these experiments are detailed, he says, "If it were possible, while the Diamond is burning, to collect the black substance which covers the surface, the Diamond would indisputably be shewn to be carbon:" that is to say, it would be recognized under the more generally known form of carbon, viz., charcoal.

Fourcroy corroborated Guyton de Morveau. He

placed two small Diamonds in a capsule, under a muffle, heated them, arrested the burning, suffering the half-consumed bodies to cool, and on removing the muffler he found them quite black, as though they had a covering of soot, which he removed by rubbing with a piece of paper, on which was left a black mark.

To Guyton de Morveau we are indebted for describing an interesting experiment made by Clouet in 1798, which consisted in converting iron into steel by heating it with the Diamond. Since steel is a combination of iron and carbon, this seems indirectly to establish the composition of the gem. Pepys, in the early part of this century, also effected the carburisation of iron-wire, by heating it with Diamond-dust by means of a galvanic battery. The experiment has been repeated in various ways by other experimentalists in modern times, notably by Margueritte in France, and Hempel in Germany, and quite recently by Professor Roberts-Austen in this country. The last named chemist used pure electrolytic iron which was heated in vacuo by means of an electric current, so as to expel all occluded gas: small Diamonds were then introduced in contact with the iron, and the metal again connected with the dynamo, when fusion occurred and the molten metal combined with the substance of the Diamond.

The brothers Rogers, two American scientists of great reputation, asserted that with potassium chromate and sulphuric acid at from 180° to 230° the Diamond is oxidized into carbonic acid. Jacquelaine and Despretz used very powerful galvanic batteries, and found that a Diamond, heated in an atmosphere of carbonic acid, by means of the oxy-hydrogen-gas blow-pipe, or one fed with carbon mon-oxide and oxygen, gradually disap-

peared without any sign of softening. Morren has recently studied the behaviour of the Diamond when exposed to high temperatures in various gaseous media.

Gassiot experimented on the Diamond by strong galvanic currents between carbon points, demonstrating that (1) In burning the Diamond, uncrystallized black carbon is first produced, which at a very high temperature, burns off into carbon-dioxide; (2) many rough Diamonds possessing a metallic lustre become leaden-grey, and (3) the blackish spots, adhering to the surface of some, may be got rid of by great heat.

Some very notable experiments on the action of heat upon Diamonds, were made a few years ago, by the late Professor Gustav Rose, of Berlin. Enclosing the stones in strong glass vessels, from which the air had been exhausted, he subjected them to the intense heat of the voltaic arc produced by Dr. Siemen's powerful dynamo machines. Air being thus excluded, the Diamonds could not be consumed, but it was remarkable that they gradually became encrusted with a dark coating of a graphitic substance resembling blacklead.

Although chemists concluded that the Diamond was a natural form of carbon, it remained for Dumas, the eminent French chemist, in conjunction with Stas, of Brussels, to undertake about the year 1840, some refined researches, which definitely fixed with extreme precision the chemical composition of the Diamond. M. Friedel in Paris, and Sir Henry Roscoe in this country, have also investigated the subject, and the chemistry of the Diamond is thus placed beyond dispute.

One of the most beautiful, and at the same time, most conclusive of experiments, both as regards the combustibility and the composition of the Diamond, may be

performed as follows:—Fill a Florence flask with oxygen, into which pour three or four ozs. of lime-water, perfectly pellucid and clear. Through the stopper of the flask lead the two wires from a galvanic battery. Join the wires inside the flask by a coil of *fine* platinum wire, wound round a Diamond. Turn on the current: the platinum wire will glow white hot, the Diamond will burst into flame, and continue burning after the current is broken. The clear pellucid lime-water will become turbid and milky, owing to the carbonic acid produced by the burning Diamond forming, with the lime-water, carbonate of lime; and finally a sediment of this solid white carbonate of lime will be precipitated, while the flask, at the conclusion of the experiment, will be found to contain carbonic acid gas.

No solvents, not even the strongest acids, have the slightest power to dissolve or decompose the Diamond; in this it is distinguished from other Precious Stones, most of which, having silica in their composition, cannot withstand the influence of hydric fluoride, or hydrofluoric acid.

THE ORIGIN OF THE DIAMOND.

All opinions as to the origin and formation of the Diamond can be arranged under three heads: (1) That it is formed immediately from carbon or carbonic acid by the action of heat: (2) That it is formed from the gradual decomposition of vegetable matter, with or without heat; (3) That it is formed from the decomposition of gaseous hydro-carbons.

(1) Leonhardt held that the Diamond was formed by *sublimation* of carbon in the depths of the earth; Parrot

that it was produced by the action of volcanic heat upon small pieces of carbon; Göbel, that pure carbon has been separated from carbonic acid by electricity in the presence of reducing agents, such as magnesium, calcium, aluminium, silicon and iron; Hausmann, that it is by the action of electricity, especially in the form of lightning, upon carbonic acid, that its decomposition is effected; and he quotes the statements of the Ancients, "that in those mines where the largest number of Diamonds were found, were so-called thunder-bolts."

(2) Among those who have supported the *vegetable* origin of the Diamond, is Newton, who believed it to be a coagulated fat, or oily body, of vegetable origin. Jameson and Brewster advanced similar views; Petzholdt also decided for the vegetable origin, basing his conclusions mainly on the microscopic study of the residual ash left when a Diamond is burnt; and Liebig, who was undoubtedly a very eminent authority by his profound knowledge of organic chemistry, says, "Science affords us no analogy, except that of decomposition and decay, for the formation or origin of the Diamond. We know that it does not owe its origin to fire; for a high temperature and the presence of oxygen are incompatible with it on account of its combustibility: on the contrary, there is undeniable ground for supposing that it was formed in the wet way; and the decomposition process alone helps us in our attempts to solve the mystery of its origin. What kind of vegetable substance, rich in hydrocarbons, the decomposition of which gave rise to the Diamond, and what particular conditions had to be fulfilled in order to crystallize the carbon, are not at present known to us; but this much is certain, that the process must have been exceedingly gradual, and in no

way hastened by a high temperature; otherwise the carbon would not have become crystallized, but would have separated itself as a black powder."

Wöhler also was of opinion that the Diamond did not originate at a high temperature, or at least not by fusion.

The late George Wilson, of Edinburgh, held the view that the Diamond might be formed from anthracite, or steam-coal, without a change from the hard state.

Dana, the venerable American geologist, regards the Diamond as a product of the decomposition of organic matter, under the operation of various agents of metamorphism. The late Carvill Lewis sought the origin of the South African diamonds in the decomposition of carbonaceous shales by the heat of certain volcanic materials thrust through them. According to the late A. Favre the paragenesis of the Brazilian diamonds suggests the presence of chloride of carbon as the substance which, by its decomposition, yielded the pure carbon. Gannal advocated the view that it results from the decomposition of carbon disulphide.

Opposed in some degree to both the above theories, but ranging under class 1 rather than class 2, is the view of Simler, of Breslau, that the Diamond is the result of the crystallization of carbon from a liquid solution. According to his theory, carbonic acid collected, in far away times, in a number of cavities, and was liquefied under great pressure; it then dissolved some pre-existing form of carbon; and subsequently the carbonic acid became gradually dissipated through fissures and clefts, and the crystallization of the dissolved carbon began. Supposing the pressure suddenly to abate, and a quick evaporation of the liquid to occur, a considerable mass of compact black Diamond might be formed, such as is known in commerce as

carbonado, or carbon. It seems not improbable that the rough, scaly, lead-coloured rind, coating the rough Diamond, may be due to vaporization thus suddenly induced. Many a puzzling appearance in the Diamond can be explained if Simler's theory be accepted: the enclosed splinters of Quartz; the occasional feathers; the peculiar form of that rough Diamond in the British Museum, which contains a moderately large cavity, whence a small yellow Diamond projects, as if it must have been ejected in a liquid condition; and finally there is that large Diamond alluded to by Tavernier, in the cavity of which was found a mass of black carbonaceous matter, weighing from eight to nine carats, which he designated vegetable mud.

(3) There has long been a lingering suspicion in the minds of many chemists that the origin of the Diamond may be possibly sought in the slow decomposition of certain gaseous hydro-carbons. Thus, Chancourtois has suggested that emanations of hydro-carbons from fissures in the earth might suffer partial oxidization, the hydrogen being converted into water and part of the carbon into carbonic acid, while the residual carbon might be deposited in a free state, just as sulphur is set free on the oxidation of emanations of sulphuretted hydrogen.

It is a significant fact that the retorts used in the distillation of coal-gas are found to be lined inside with a remarkably dense and hard deposit of carbon, not unlike the natural carbonado. But perhaps the strongest evidence in favour of such a view is to be found in the experiments described some years ago by Mr. J. B. Hannay, of Glasgow. This experimentalist startled the scientific world by declaring that he had at last solved the great problem of diamond-making. His researches unquestionably made a great stir for a while; two papers appeared in the

Proceedings of the Royal Society, and letters in the newspapers led the public to suppose that instead of digging for Diamonds in distant parts of the world we should henceforth get them from our laboratories at home; but when the excitement had subsided the subject was allowed to drop, and not a syllable has been heard for years about the artificial Diamonds of the Scottish chemist.

As Mr. Hannay's experiments have failed to have the slightest commercial interest, it is needless to do more than offer an outline of his method. Paraffin spirit was submitted to prolonged heat in company with one of the alkaline metals, notably lithium, and in the presence of bone-oil distillate which contained certain nitrogenous bases, the action of which in facilitating the reduction of the carbon from the paraffin was by no means clear. This strange mixture of substances was placed in a strong wrought iron-tube, having its ends securely welded together. It was then subjected for many hours to the heat of a reverberatory furnace. In most of the experiments the tubes exploded, tearing the metal open, and even in some cases shattering the furnace, and injuring the assistants. Now and then, however, a successful experiment was made; and then, on sawing open the iron tube, its interior was found to be incrusted in places with a hard black mass, which contained embedded fragments of a transparent substance which was reported to be *crystallised carbon in a Diamond-like form!* The great difficulty and danger of the experiment, and the insignificant amount of diamantoid carbon obtained even in the most successful attempts, have not invited any repetition of the investigation; so that Mr. Hannay's researches are only of scientific interest, and are never likely to yield a single Diamond as an ornamental stone. Mr. Hannay

admitted to the author, at one of the Royal Society's Meetings, that his artificial product, when placed on the wheel for cutting, crumbled to pieces.

Geographical Distribution of Diamonds.

The localities of the Diamond are India, Sumatra, Borneo, Brazil, and South Africa, parts of North America, British Guiana, the Ural mountains, and Australia. Other countries have been pointed out, but confirmatory evidence of the truth of this assertion is required. In 1833, it was reported that in the gold-sand of the river Gumel, in the Algerian province of Constantine, three Diamonds had been discovered. The idea that Algeria was a land of Diamonds seems to have been at once entertained. Dr. Cuny, an African traveller, reported that a whole camel-load of Diamonds had come from West Africa to Darfur in 1859,

According to Murray, who published a Memoir on the Diamond in the early part of this century, a Diamond was once found in a brook in Co. Fermanagh, Ireland.

It is said that in 1870 a Diamond was found in the pyrope-bearing sands of Dlaskowitz in Bohemia, and the assertion seems to have had foundation in fact. At the same time there is always the chance of an isolated specimen having been artificially transported to the locality, and thus having no real scientific significance.

It is believed that the first Russian Diamonds were found by a boy on June 22, 1829, at the Biszer Gold Washings, of the Countess Porlier, about 160 miles to the west of the town of Perm. Just at that time Humboldt was exploring the Urals, and his companions are said to have found Diamonds at the above-mentioned locality.

The principal Diamond districts of the world will be described in detail in the following pages.

Mention should here be made of a remarkable discovery which has recently invested the Diamond with an interest even greater than that which it could previously claim. On September 22, 1886, three meteorites or sky-stones fell near Novo Urei, in a remote part of South-Eastern Russia. These strange visitants from space were subjected to scientific examination by MM. Jerofeiff and Latchinoff, who ultimately submitted the results of their enquiry to the French Academy of Sciences. And these results were of a most startling character! In one of the meteorites, carbon was found in a diamantoid condition, forming about one per cent. of the entire weight of the stone. It is true that this carbon was rather of the character of carbonado, the black variety of Diamond, to be subsequently described; but still the presence of any kind of Diamond in an aerolite is a fact of surpassing scientific interest, while even those who are not scientific, will not fail to appreciate the importance of finding this remarkable mineral in a heaven-dropped stone, thus enabling us to assert that we have at last detected a veritable "Diamond in the sky."

DIAMOND.

Composition	Pure Carbon.
Specific Gravity	3·52 to 3·53.
Hardness	10.
System of Crystallization ...	Isometric or cubical.
Common Forms of Crystal...	Octahedron, Rhombic Dodecahedron, Hexakis Octahedron, &c

CHAPTER II.

SOUTH AFRICAN DIAMONDS.

IT has been supposed that Diamonds were not known to exist in South Africa until about five and twenty years ago; but this supposition is undoubtedly erroneous. On the contrary it is certain that their presence in this region was known to the European colonists in the eighteenth century. Boyle observes that "the existence of Diamonds" in South Africa, had been several times asserted before the English conquest of Cape Colony. It was so far accredited in the middle of the last century, that the words " Here be Diamonds " are to be seen inscribed across our modern territory of Griqualand West, in a Mission Map of 1750. The old Dutch residents of Cape Town appear to have been quite astir about the matter on several occasions, but years passed on and the ancient rumours died away.

Rather more than twenty-five years ago, it happened that a child of Mr. Jacobs, a Dutch farmer settled at the Cape, amused himself by collecting pebbles from the neighbourhood of the farm, near Hopetown. At first sight there might seem nothing remarkable in this circumstance,

CAPE DIAMOND in Matrix.

CAPE DIAMOND in Matrix.

for pretty pebbles were to be had in plenty near the neighbouring river. One of these stones, however, was sufficiently bright to attract the keen eye of the mother, though she regarded it simply as a curious pebble, and gave it little more than a passing glance. Some time afterwards a neighbouring boer, Mr. Schalk van Niekirk, visited the farm, and, knowing him to be curious in such matters, Mrs. Jacobs called his attention to the bright transparent stone. So little heed, however, had been given to the pebble, that when wanted it was nowhere to be found ; and it was only after diligent search that it was at last discovered outside the house, just where it had happened to fall when the child had last used it as a plaything. Van Niekirk was sorely puzzled with the stone, yet thinking that it might possibly have some value, offered to buy it of Mrs. Jacobs. The good woman laughed at the notion of selling so common a stone, and at once gave it to the enquiring farmer.

Just then it chanced that Mr. J. O'Reilly was returning from an expedition in the interior, and to him Van Niekirk confided the stone, with a request that he would endeavour to ascertain its nature from any trustworthy mineralogist whom he might meet. By Mr. O'Reilly the stone was taken to the town of Colesberg. Few people at this time believed that Diamonds occurred in South Africa, and when O'Really cut his initials on a window-pane of the hotel at Colesberg, it was supposed that he was using simply a fragment of common quartz or rock crystal. To show O'Reilly that even flint would do this, a gun-flint was obtained and found to scratch the glass readily enough. Indeed, some one staying at the hotel threw O'Reilly's stone into the street, as a practical joke, and it was only after prolonged search that it was recovered.

Notwithstanding the ridicule of the bystanders, O'Reilly clung bravely to the notion that he had got a Diamond, and he afterwards showed the stone to Mr. Lorenzo Boyes, the Clerk of the Peace of the district. Mr. Boyes knew that his friend, Dr. G. W. Atherstone, of Graham's Town, was an excellent mineralogist; and, anxious to get his opinion, he sent the enigmatical stone through the post, accompanied by an explanatory letter. Had it been suspected that the stone was of any exceptional value, the envelope would no doubt have been carefully sealed, and the letter duly registered. As a matter of fact, however, the envelope containing the stone was simply gummed, and despatched as an ordinary letter. When it reached Graham's Town, the good doctor had some little difficulty in deciding what the curious pebble could be, and he consulted Bishop Ricard, the Roman Catholic Bishop of Graham's Town. After carefully examining its physical characteristics, after testing its degree of hardness, its density, and its behaviour when subjected to optical tests by means of polarized light, they were bold enough to pronounce it a genuine *Diamond!* This was in March, 1867, and the Universal Exhibition in Paris was about to open in the spring. What more appropriate, the doctor thought, than to send this stone to Paris? Here was the greatest novelty the Colony could exhibit—the first African Diamond of modern days! *Semper aliquid novi Africa affert,* "Africa turns up something new continually." Dr. Atherstone accordingly communicated his suggestion to the Colonial Secretary, the Hon. R. Southey, and in consequence of this suggestion the Diamond was duly conveyed by steamer to Cape Town, where it was examined by the French Consul, M. Heriette, who having confirmed Doctor Atherstone's judgment and determination as to the

stone, forwarded it in due course to Paris. There it stood during the whole of the summer, and having been examined by *savants* of all nations, it was purchased at the close of the Exhibition by Sir Philip Woodhouse, at that time the Governor of the Colony, for the sum of £500. The weight of this Diamond was $21\frac{3}{16}$ carats. It was sold to Garrard's by Sir P. Woodhouse, and cut by them as a brilliant.

Such is the history of the discovery of the first Cape Diamond. O'Reilly soon afterwards found a second stone weighing $8\frac{7}{8}$ carats, which realised £200. This man may, therefore, be justly regarded as the pioneer of the great diamond-mining industry of South Africa; yet he passed into obscurity and derived but little real benefit from his good luck and sagacity.

Mr. Van Niekerk, who also played an important part in the early history of the diamond fields, shortly afterwards obtained from a native a diamond weighing $83\frac{1}{2}$ carats, which he sold in Hopetown for £11,200. This stone when cut, became known as the "Star of South Africa," and will be noticed on a later page. Other discoveries, rapidly following one another, led to the development of the great Diamond-fields of South Africa.

These fields are situated chiefly in the Colony of Griqualand West, which was proclaimed British territory in 1871. The colony is intersected by the river Vaal; and it is in the Vaal Valley, and in that of some of its tributary streams, such as the Modder and the Vet, that the "river diggings" were established. Drawing its head-waters from the Draakensberg or Quathlamba range of mountains, far away in the east, on the borders of Natal, the Vaal river, or the Ky Gariep, flows in a sinuous course, generally in a westerly direction, until it joins the Orange river, or the Nu Gariep. This, the greatest known stream in South

Africa, runs for more than 900 miles in a westerly course and finally rolls its burden of waters into the Atlantic. The chief productive localities are situated in the neighbourhood of the Middle Vaal, about 60 miles above the confluence of the two streams, but Diamonds have also been found in the valley of the Orange river, at least 50 miles below its junction with the Vaal. In fact the area from which Diamonds have been obtained is of vast extent. To the north, it certainly reaches as far as Blomhof, near Pretoria, the capital of the Transvaal; and Diamonds have been found at least a hundred miles nearer the sources of the Vaal. On the south side of the Orange river, they occur some miles to the north-west of Hopetown. Jagersfontein, 96 miles south of the Vaal, is a well-known locality; and a stone of 70 carats has been found at Mamusa, 75 miles beyond Jagersfontein.

Until the discoveries of Diamonds directed attention to this district, scarcely anything was known of its geological characters. Stripped of all superficial deposits, the solid framework of the country appears to consist of rocks belonging to that great geological series which, from its conspicuous occurrence in the "karoos," or vast plains in the interior, has received the name of the *Karoo-formation.* This formation is developed to a vast extent in South Africa, occupying indeed by far the larger portion of the country, and covering at least 200,000 square miles, whilst its thickness is estimated at 5,000 feet. For the most part it consists of shales and sandstones, which represent old deposits of mud and sand, now hardened and altered, but originally thrown down as sediments in a vast fresh-water lake. Africa is still famous for its large sheets of inland water; but the lakes in which the karoo beds were deposited are of great geological antiquity, probably corresponding

roughly in time with the period at which the New Red Sandstone of this country was formed. Although for the most part destitute of fossils, the karoo strata are in places rich in organic remains, the most notable being the relics of extinct reptiles, which must have lived near the margin of the waters which deposited the ancient sediment.

In addition to these remains of extinct animals, we find in many of the karoo-beds numerous vegetable relics, in some places in the form of fossil-wood, while elsewhere the wood has been converted into coal. The coal seams of the karoo series occur especially in the upper part of the formation, and notably at the Stormberg. By the action of heat, some of the Stormberg coal has been converted into anthracite or steam-coal, a variety of fossil-fuel peculiarly rich in carbon ; whilst the occurrence of graphite, or " black-lead," in some of these beds, has been regarded as the result of further modification of the coal. As graphite is but an impure variety of carbon, whilst we know that the Diamond is simply a pure crystallized form of the same element, some geologists have been tempted to speculate as to the possible effects of further metamorphosis upon the graphite, and have thus dimly seen in the vegetable fossils of the karoo formation the ultimate origin of the South African Diamonds. If this metamorphic action has been found sufficiently potent to transmute vegetable matter into coal then to convert the bituminous coal into anthracite, and possibly afterwards to transform the anthracite into graphite, why should its potency be arrested at this point ? Let the same kind of action be continued, and we are brought to the logical conclusion that the ultimate term of the series will eventually be reached ; and this ultimate term is assuredly represented by the Diamond. It will be shown in succeeding pages that most of the South African

Diamonds occur in a volcanic breccia, and it has been suggested that these Diamonds have been derived from the carbonaceous matter of the karoo shales during the upward passage of the molten or partially-molten matter from some deep-seated source.

In certain places the lacustrine shales and sandstones of the karoo-formation are cut through by dykes or veins of various eruptive rocks, known popularly as "trap;" whilst in other places similar igneous rocks are spread out in sheets, intercalated between the sedimentary strata. It is in the neighbourhood of these old lava-like rocks that the coal is locally converted into anthracite. But the "traps" associated with the karoo-beds have other points of interest in connection with our present subject. Varying considerably in their characters in different localities, some of them exhibit a vesicular texture, and contain in their bubble-like cavities kernels of Chalcedony, Agate, Jasper, and other siliceous minerals. By the disintegration of such rocks, the hard Agates and kindred stones are set free, and carried down as pebbles by the rivers. Indeed the shingle of the Orange and Vaal Rivers has long been famous for the beauty of its Agates and other pebbles. In addition, however, to these attractive chalcedonic pebbles, the shingle contains a great variety of other minerals, among which there is one of paramount interest—the Diamond itself. It was in the Agate-bearing gravels of the Vaal and Orange Rivers that the Diamond washer originally established his "river-diggings."

The search for Diamonds along the Vaal River commenced in 1868. According to Mr. R. W. Murray, the earliest Diamond-searching party was formed in Bethulie under Mr. J. B. Robinson, and established themselves near Hebron. Then followed a party from Natal, who set to

work with intelligence—systematically digging the soil from the banks of the Vaal, and washing it in a cradle for Diamonds just as they might cradle it for gold. Another party from Kaffraria established themselves at Klipdrift, on the other side of the Vaal. Klipdrift was afterwards called Barkly. Still later, another contingent of fortune-hunters were led to dig near a hill named Pniel, and thus founded the famons Pniel workings opposite Barkly West.

Although the river-diggings declined in importance after the discovery of the "dry-diggings," they will always be of great interest from the fact that they represent the earliest workings in the South-African Diamond-districts and produced the finest quality of Diamonds. Even at the present day stones of great purity are still found in the river-workings.

How the Diamonds got into the river gravels is a point, which puzzled many a geologist. The rounded character of the pebbles, and the frequent presence of fragments of fossil wood, much rolled and water-worn, seem to indicate that the materials of the gravels must have travelled from a great distance. Zones of similar fossil wood are known to occur in the karoo beds of the Stormberg and the Draakensberg; and it has been suggested that the materials of the Vaal gravels have been brought down from the head waters of the river. It seems equally probable, however, that the Diamonds may have been introduced into the gravels at some other part of the course of the river. In fact, the late Mr. Tobin, the pioneer of the author's Diamond Expedition Party, in 1870, showed that the source of the Vaal is in sandstone, and that the Agate pebbles are not to be found in the stream until after it has traversed a distance of several miles.

It was soon found that the Diamond-bearing gravels

are not confined to the present bed of the river. Terraces of similar gravels run along the margins of the river, at a considerable elevation, and many of the larger Diamonds have been found in these old high-level gravels. Such gravels unquestionably owe their origin to the former action of the river, when it flowed at a much higher level.

But, in addition to the deposits along the margins of the river valleys, there are superficial accumulations of gravel, sand, and clay widely spread over a vast area of the country. These wide-spread deposits of drift conceal the surface, rising up the sides and covering the summits of the little hills which form so marked a feature in the scenery of the Diamond districts. These hillocks, or knolls, which in some cases attain to a height of upwards of 100 feet, are known locally as *kopjes*, and the discovery of Diamonds on some of these *kopjes* led to the establishment of the "dry diggings."

The most remarkable group of Diamond mines in the world is formed by the four celebrated workings known as Kimberley, De Beers, Du Toit's Pan, and Bultfontein. It is notable that they are close together, and were all discovered within a space of about six months. The origin of these mines is of great interest. A Dutch Boer, named Van Wyk, who occupied a farmhouse at Du Toit's Pan, was surprised to find Diamonds actually imbedded in the walls of his house, which had been built of mud from a neighbouring pond. This led to examination of the surrounding soil, wherein Diamonds were found. On deepening the digging, Diamonds were still brought to light; nor did they cease when the bed-rock was at length reached. Such was the origin of the famous Du Toit's Pan.

The estate known as Vooriutzigt was the property of Mr. De Beer, and after Diamonds had been discovered

at Du Toit's Pan and Bultfontein, workings were commenced there with such success that a mining camp soon sprang up, known as Old De Beers. In July, 1871, a fresh centre of discovery was reported at a small hill or *kopje* situated at only about a mile from De Beer's, where a young man having taken shelter from the sun under a mimosa-bush, accidentally found a Diamond by scraping the soil with his knife. A rush naturally ensued, and the locality became known as the "Colesberg Kopje," or the "New Rush," while the surrounding town, which to meet the wants of the new comers sprang up with mushroom-like celerity, received the name of Kimberley, in compliment to the Earl of Kimberley, at that time H.M.'s Secretary of State for the Colonies. The town of Kimberley lies between the workings of the Kimberley mine and De Beers. Bultfontein, one of the earliest mines, originally belonged to Mr. Du Plooy, who sold it in 1870.

The site of each Diamond mine is a more or less circular area, surrounded by horizontal shales, the edges of which are slightly turned upwards round the margin of the area. This evidently suggests that the shales, which were originally horizontal, have been pushed aside by the intrusion of matter forced from below. Indeed, all geologists now maintain that the Diamond-bearing rock is of eruptive origin, being a kind of volcanic mud, and has passed upwards in columnar pipes, and been thrust through the surrounding shales. Thus, Mr. Dunn regards the pipes as "merely the channels that connected ancient volcanic craters with deep-seated reservoirs of molten rock."

The upper portion of each pipe was found to consist of the reddish sandy soil of the country, accumulated no doubt by the action of wind. Below this came a layer

of calcareous tufa, or a light deposit of carbonate of lime; and it was by no means uncommon to find Diamonds adherent to this tufaceous rock. At a still lower depth, the main contents of the pipe were reached. This consisted of an altered volcanic rock, in places much broken up, and passing into a breccia. The upper part of the rock was oxidised by meteoric agencies, and was known from its colour as "yellow earth." This passed downwards into the "blue ground."

The exact nature of this material puzzled petrologists for a long time; but the rock was most carefully examined by Prof. Nevil Story-Maskelyne, M.P., and afterwards by many Continental petrographers, especially by Cohen and Fouqué and Lévy. Carvill Lewis suggested that the blue Diamond-bearing rock should be distinguished under the name of *Kimberlite*. The base of the rock is a soft mineral, soapy to the touch, and of green or bluish color. Prof. A. Stelzner, of the Mining Academy of Freiberg in Saxony, regards the blue matrix as an altered olivine-diabase; the whole rock being more or less serpentinized. It contains angular fragments of shale, more or less altered, associated with various distinct minerals. The minerals, in addition to the Diamonds, are pyrope, or chrome-garnet, chrome-diopside of bright green colour, enstatite, mica, vaalite, zircon, cyanite, hornblende, barytes, magnetite, chromite, titaniferous iron-ore, etc. But the only minerals that attract the miner's attention are the Diamonds. These are sprinkled pretty freely through the "stuff;" sometimes as beautifully formed crystals, but frequently as mere fragments and splinters. They are said to be most abundant in the neighbourhood of doleritic dykes, but their distribution is very irregular; in one claim they may be richly disseminated, whilst in the neighbouring claim they

are but sparsely scattered through the rock. Each rock is said to yield Diamonds easily distinguished from those of other pipes, so that buyers on the field can generally tell, on looking at a stone, from which locality it has been obtained. These local peculiarities suggest that the stones have been formed in or near the centres where they are now found. Indeed, it has been maintained by some, that the rock, now filling the pipes was, in its unaltered state, the original home of the Diamond—that the gems are in fact in their proper matrix. In support of this view, it has been pointed out that most of the crystals are sharp at the edges, and exhibit no signs of abrasion, such as we might expect to find had they been transported far from their original site. On the other hand, a large proportion of the crystals have evidently been shattered, and exist now as mere fragments, showing that the rock has suffered great disturbance, though it may only have been during its projection to the surface from some deep-seated source. It is a curiously significant fact, well worth noticing, that many of the crystals of Diamond in these pipes exhibit on their octahedral faces, regular triangular depressions, strongly suggestive of the triangular striations which the late Gustav Rose produced on Diamonds, by heating them in a muffle, so as to undergo incipient combustion.

The volcanic mud rising from below and bringing with it the Diamonds ascended the pipes, but appears never to have overflowed around the vents. The pipes were not all filled at the same time, nor was the blue earth of one pipe due to a single ascent of the material. Thus both in De Beer's and in Kimberley the " blue " of the west side is unlike that of any other part of the mine; it carries but few Diamonds and these present distinctive characteristics.

It is interesting to note the nature of the rocks through which the volcanic material forced its way upwards. Beneath the red soil of the country is a decomposed basalt, and this is followed by black carbonaceous shales, dipping slightly to the north. The shales are from 200 to 250 feet in thickness, and it has been assumed, probably on too slender a basis, that the Diamonds may have resulted from the action of the olivine rock on the carbon of these shales. Beneath the shale is a bed of conglomerate, which rests upon an amygdaloidal olivine-diabase, often described as a melaphyre, and representing an old lava-flow, about 400 feet thick. The rock beneath this ancient lava is a quartzite of great but undetermined thickness.

Igneous dykes penetrate these rocks almost vertically. One of the most interesting of these dykes is the large mass in De Beers' mine, known as the "Snake." According to Professor Stelzner this rock is a pikrite-porphyry, much altered, and he believes that, though destitute of Diamonds, it was derived from the same subterranean source whence the blue earth took its rise.

In the early days of Diamond-mining in South Africa, the ground in the volcanic necks was worked as quarries, or open casts, and the material was hauled up by means of aerial wire ropes. Much inconvenience was experienced as the diggings grew deeper, especially by the heavy falls of the surrounding shales, or "reef," which tended to slip in large masses into the workings. The shales contain iron-pyrites, and have occasionally ignited spontaneously, with disastrous results.

About seven years ago an entirely different system of working was introduced at the Kimberley Mine and this was soon followed at De Beers. Shafts were sunk and successive galleries driven into the Diamond-bearing

ground, as in the ordinary system of underground mining. The rock is brought down by drilling and blasting, and is run in trucks to the bottom of the shaft, up which it is hoisted in skips running on steel rails and worked by a steam winding-engine. The mines are fitted with all modern improvements, such as electric lamps and telephones connecting the different centres of work.

Arrived at the surface, the blue-earth is dumped into a hopper, whence it is discharged into trucks which are carried by an endless wire cable to the weathering floors. Spread out upon this ground, it is exposed to the disintegrating action of solar heat and atmospheric moisture, and its pulverisation is assisted by the earth being turned over from time to time, harrowed, and artificially watered. The Kimberley blue is said to become well disintegrated by exposure for about three months during the summer, while the De Beer's stuff requires exposure for double this time.

When sufficiently broken up, the earth is washed in pans, and the residue carried to the dressing floor where it is treated in the "pulsators," which, like the jiggers of ore-dressing machinery, sort and size the materials in various degrees of fineness. The clean gravel and sand is then carefully examined on sorting tables, and the Diamonds picked out by hand. The final operation is to clean the Diamonds by boiling them in a mixture of nitric and hydrochloric acids.

The four mines of De Beer's, Kimberley, Du Toit's Pan and Bultfontein are practically under the control of the powerful combination known as "De Beers Consolidated Mines, Limited." This Company, of which the Hon. Cecil Rhodes is Chairman, has a capital of £3,950,000. During the year ended March 31, 1890, the amount of blue ground

hauled from De Beer's and Kimberley was 2,192,226 loads. A load weighs about 1,600 pounds. During the same year 1,325;400 loads of blue ground were washed at De Beer's and Kimberley, and 625,700 loads at Du Toit's and Bultfontein. The aggregate yield of Diamonds was 1608,830 carats, which realised the sum of £2,641,557 19s. 3d.

Enormous as the yield of Diamonds undoubtedly is, there can be no question that if necessary it could be vastly increased. The policy of the company has been to restrict the output in order to maintain prices, and at the present time the poorer mines are practically closed.

It is estimated that every load of blue ground from the Kimberley mine yields on an average from one and a quarter to one and a half carats of Diamonds; from De Beer's mine, one and a fifth to one and a third carats; from Du Toit's Pan one-sixth to one-fifth carat; and from Bultfontein only one-fifth to one-third of a carat.

It is curious that these four famous mines so close together and discovered at so nearly the same time, should for many years have remained practically the only Diamond mines in Griqualand West. Early, however, in the present year (1891) a new discovery, promising to become of great importance, was made on the farm known as Benaudheidfontein, in the district of Kimberley. This farm was the property of Mr. J. J. Wessels, senior, and hence the mine has come to be known as the Wesselton Diamond mine. Great numbers of diggers have rushed to the spot and pegged out claims, but up to the time these pages are passing through the press the mine has not been proclaimed as a public digging.

In order to prevent the theft of Diamonds at the mines, the native kaffirs, or "boys," employed at the Kimberley Mines are confined in an enclosed village, or

"compound," and the strictest supervision exercised over them. The Diamond trade is regulated on the fields by the "Diamond Trade Act," known commonly as the "I.D.B. Act," its object being to prevent Illicit Diamond Buying. But, notwithstanding its stringency and the severity of the punishment accorded by the Special Court, the I.D.B. trade still flourishes.

One of the most interesting features in the Diamond production of South Africa is the large number of stones of unusual size which have been brought to light. The first which acquired notoriety, named the "Star of South Africa," now known as the "Dudley Diamond," was, in the rough, of an irregular shape, and about the size of a small walnut; its weight was 83½ carats. After cutting, this was reduced to 46½ carats. It is triangular in shape, of great brilliancy, perfectly colorless, and cannot be distinguished from an old Indian stone. This gem, in 1869, came, as already mentioned, into the possession of Schalk van Niekirk, who obtained it from a kaffir doctor or sorcerer. Subsequently, it was exhibited at Port Elizabeth and Cape Town, when it was visited by crowds of people. By Messrs. Lilienfield Brothers, of Hopetown, who purchased it of Van Niekirk for £11,200, it was shipped to England, and passed into the possession of a Bond-Street firm of jewellers, by whom it was cut and sold to the late Earl Dudley. It was mounted by them, with other Diamonds, with enhanced effect, as a head ornament.

A Diamond of pale yellow tint, weighing 112 carats, was brought to the late Prof. Tennant by an old student, and when cut yielded a Brilliant of 66 carats. This stone has now found a home with the King of Siam. Again, a stone of 124 carats was found at Du Toit's Pan, on July 21, 1871. Another large and well-known South-African

Diamond is the famous "Stewart." which was found in 1872, at Waldeck's Plant, on the Vaal River, and consigned to a London firm. It weighed in its rough state 288⅜ carats, or nearly two ounces troy. It is of a light yellow colour, beautifully crystallized.

"The claim from which the gem was taken was originally owned by a Mr. F. Pepper, by him sold to a Mr. Spalding for £30, and handed over by the latter to one Antoine, to work on shares. The claim was quite an outside one, and not thought much of by the owner, but as others were finding near him, he thought it was just possible he might also find a gem. He persevered until, first, the 'Fly Diamond,' and next, after further toil, this prize rewarded his labour. Antoine's feelings when he first obtained a glimpse of the treasure may be better imagined than described. He says that he was working in the claim, when he told his boy to leave off picking in the centre and commence at the side. Not being understood by the boy he took a pick and began himself, when he was suddenly spell-bound at the sight of a large stone, with the primary aspect of a Diamond. For some minutes he could neither speak nor move for fear of dispelling the apparent illusion, but, collecting his energies, he made a dart forward and clutched the prize."

At Jagersfontein, in the Orange River Free State, a Diamond of 209¼ carats was discovered, and it is said that this magnificent stone was purchased of a kaffir by an illicit Diamond buyer for the absurd sum of £15. A Diamond weighing over 600 carats, but very impure, was unearthed some years ago at these diggings.

One of the finest South African Diamond ever discovered was found on February 12, 1880, in a claim at Kimberley, belonging to Mr. Porter Rhodes. It is true

CRYSTAL OF YELLOW CAPE DIAMOND.

that in weight it has been exceeded by many other stones, but in purity of colour it has very few rivals. It weighs 150 carats, and placed by the side of Cape stones, having a slight tendency to yellowish tints, it seems to present the faintest possible shade of blue. This magnificent "blue-white" Diamond, which was valued by its owner at £200,000, was publicly exhibited at Mr. Streeter's establishment.

The largest Diamond ever found in either of the four mines at Kimberley was a noble octahedral crystal from De Beer's, weighing in the rough 428½ carats. This stone was sent to the Paris Exhibition of 1889, where it was cut to a brilliant weighing 228½ carats. A figure of this stone before cutting, shewing its form and natural size, is given as a tail-piece at the end of this chapter, p. 91.

While South Africa has thus been remarkable for yielding stones of exceptionally large size, it must also be admitted that the quality of the gems brought to light is by no means unsatisfactory. True, a large number of the Diamonds are "off-coloured" stones, generally exhibiting a delicate straw-tint, but none the less they are extremely brilliant when properly cut. A very fair proportion of the South-African Diamonds are of the first water, rivalling in beauty and purity the finest Brazilian and Indian Stones. This is especially the case with the Diamonds from the Jagersfontein mine. With regard to the Kimberley mines it is found that iron pyrites exists in large quantities, and the theory has been broached that to this cause is due the extraordinarily large number of coloured or "off-colour" stones, that are found there; while in the Jagersfontein mine iron pyrites is not found, and nearly all the Diamonds found there are the purest white.

The great majority of these stones are not only pure in colour, but splendid crystals, symmetrical in shape, and readily cut.

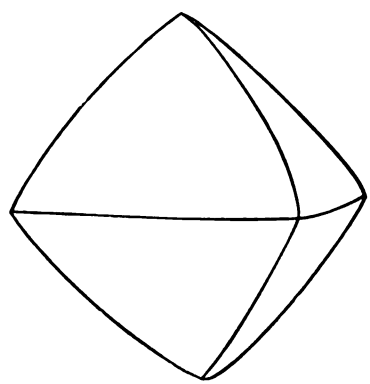
It has been estimated that about 20 per cent. of the Cape Diamonds are of the first quality; 15 per cent. of the second; and 20 per cent. of the third; the remainder being "bort." All Diamonds which are too impure for cutting are now known under the general name of *bort;* and these possess a fixed market value, the powder which they yield when crushed, being used for cutting and polishing Diamonds and other stones, and in the engraving of gems of exceptional hardness.

An interesting specimen on view at the author's, exhibits several octahedral crystals of Diamond grouped around a central nucleus of dark-coloured bort. This specimen weighs 19 carats, and was obtained from the Diamond-fields by explorers, privately sent out by the author.

During the time the expedition was working at the Cape, the superiority of the river stones over those from the dry diggings, induced the writer to suggest that machinery should be sent out for the purpose of turning the course of the Vaal river. The object in view was to work in the river-bed. The project was reluctantly abandoned in consequence of the ill-health of the leader of the expedition. The history of the great findings of Indian Diamonds rendered it most probable, that the finest stones would occur in the bends of the river-bed, and events have shewn the correctness of these anticipations. A "drop," with a twin of clear cinnamon colour, discovered in the Cape diggings, was pronounced by Diamond merchants of great experience, to be an Indian, and not a Cape Stone.

Notwithstanding the enormous number of Diamonds which have been brought to light during the recent

workings in South Africa, it is notable that, so far as the author knows, not a single piece of *Carbonado*—the black, impure variety of Diamond found in Brazil—has yet been discovered, though the ilmenite, or titaniferous iron-ore, sometimes passes improperly under the name of carbon. In fact, while certain points of resemblance have been traced between the occurrence of Diamonds in Africa and in Brazil, there are other points in which such a comparison entirely breaks down. It would be more correct, in many respects, to assert that the Diamond-fields of South Africa are absolutely unique.



THE LARGEST KNOWN KIMBERLEY DIAMOND.
NATURAL SIZE IN ITS ROUGH STATE.
WEIGHT, 428½ CARATS.

CHAPTER III.

BRAZILIAN DIAMONDS.

IN washing the sands of some of the Brazilian rivers, for sake of the gold which they contained, the natives in the early part of the last century occasionally lighted upon little hard stones of peculiar shape, which they regarded as of no value; they either threw them away, or used them as counters in card-playing. It was not until 1727, that Bernardo da Fonseca Lobo, an inhabitant of Serra do Frio in the gold district of Minas-Geräes, accidentally discovered the true nature of these stones. He had seen rough Diamonds in India, and the likeness to these was so striking that he took a number to Portugal for sale, and thus drew general observation towards the new Diamond mines. Such at least is the usual story of the discovery of the Brazilian Diamond fields.

The European merchants, who up to that time had obtained their Diamonds from India, were frightened lest this discovery should cause a fall in the price of the gems in their possession. They consequently spread the report that the Brazilian Diamonds were only the refuse of the Indian stones, forwarded to Goa, and thence to Brazil.

The Portuguese, however, turned the tables, and sent

the Brazilian Diamonds to Goa, and thence to Bengal where they were offered for sale as Indian stones, and obtained Indian prices.

It is only within the last few years that the Diamond-bearing rocks of Brazil have been sufficiently studied to enable geologists to speak with anything like confidence in regard to their nature and their age. Observers, it is true, have been many, but the observations have mostly been of so superficial a nature, and in many cases, so contradictory, that it was almost impossible to deduce any satisfactory conclusions. Of late years, however, the Diamond-bearing regions have been thoroughly examined, especially by Prof. Gorceix, the head of the School of Mines at Ouro Preto, the capital of Minas-Geräes, and by Prof. Orville A. Derby, of the Museum at Rio, Janeiro. Sections have been made of the strata, of which the Diamond-bearing provinces are composed, and a satisfactory sequence has been established.

The mode of occurrence of Diamonds at Diamantina (formerly called Tejuco), in the province of Minas-Geräes may be fairly taken as typical of the workings throughout the country. It was here that Diamonds were originally discovered in Brazil, and it was to this district that the workings were for a long time restricted. Diamantina itself is situated along the crest, and on both flanks of the great interior mountain range of Brazil, which, at a general height of about 4,000 feet above the level of the sea, divides the waters of the São Francisco on the west, from those of the Doce, Jequetinhonha and other rivers on the east. The northward prolongation of the range includes the Diamond regions of Graò Mogol, in the province of Minas-Geräes, and that of the so-called Chapada Diamantina in Bahia.

A very important group of rocks stretches from the former to the latter of these rivers. This group has been called the Itacolumite series, from the occurrence of *Itacolumite*, a rock which was named by Eschwege, from the Serra do Itacolumi. The true Itacolumite of petrologists is a sandstone, remarkable for possessing flexibility, so that a thin slab admits of being readily bent to and fro. This peculiar rock is, however, only a rare variety of the Itacolumite, most of which is a granular schistose quartzite, or metamorphic sandstone, destitute of flexibility.

The Brazilian Itacolumite has long figured in works on mineralogy as the original matrix—the true parent-rock—of the Diamond ; and the occurrence of a somewhat similar rock with Diamonds in India and in North Carolina has led to premature generalizations as to the origin of the gem.

In the geological section under description, the Itacolumites are associated with a group of hydro-mica schists and Itaberites, or schists containing specular iron-ore. Traversing these rocks are certain more or less defined veins of clayey matter containing Diamonds. The mineral is here supposed to occur in its primitive position, the clayey material being probably its decaying matrix. Diamonds are also found in the quartzites of an overlying series, but here they are to be regarded as pebbles washed out of their original home in the lower group of rocks. They are likewise distributed through the gravels of the Brazilian Highlands, where they find a resting-place after having been set free from their enclosing matrix. It is possible then that a Diamond, born originally in the lower metamorphic series, may have been transported among the materials which enter into the constitution of the upper series, and then on the wearing down of these

upper rocks, may have been once more disturbed, and finally deposited in the gravels of the present river valleys. Such appears to be the geological history of many a Brazilian Diamond.

The late Mr. Hodder M. Westropp, a gentleman well-known for the attention which he had given to the subject of Precious Stones, wrote as follows :—

"Itacolumi is a mountain near Ouro Preto (Villa Rica of old maps), the capital of the province of Minas. It is outside of the Diamond regions, but contains the characteristic rocks of that region. True Itacolumite belongs to the Diamond series, but so far Diamonds have not been found in it, though they have been found in a rock hitherto confounded with it, though of late geological age, and of conglomerate character, the gem entering as a rolled pebble from the older and true parent formation."

The Diamond washings in the neighbourhood of Diamantina are performed either in old river gravels or in the beds of rivers, in whose bottoms continuous pot-holes or cañons are found, filled with the Diamond-bearing gravel. The courses of the rivers are turned by means of temporary dams or wooden sluices, and the Diamond-bearing gravel hollowed out. The principal minerals associated with the Diamond are anatase, rutile, brookite, specular iron, martite, topaz, tourmaline, and native gold.

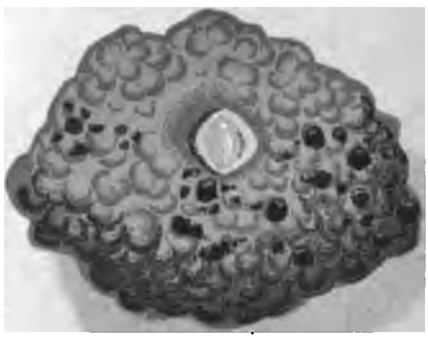
At São João da Chapada, about 12 miles to the west of Diamantina, the Diamond occurs embedded in clay, or *barro*, under conditions which have been described by Prof. O. A. Derby. The clay contains grains of quartz and microscopic tourmalines, but the rock from which it has been derived by decomposition has not been definitely detected.

About 100 miles north of Diamantina, on the Corrego

dos Bois, near Grão Mogol, the Diamond has been found in a solid conglomerate rock named by the miners "Pigeons' eggs." This was formerly regarded as the Itacolumite, but has lately been identified with the upper series, overlying the true Itacolumite group. In 1839 about 2,000 people flocked here to work.

Diamonds occur in the valley of the River Tibagy (in the Province of Paraná, in Southern Brazil) and in its tributaries the Yapo and Pitangru. The stones are found not only in the sands of the river, especially in pot-holes, but in old beds of gravel at some distance above the present level of the river, where "dry washings" have been established. The story told of the discovery of Diamonds here is, that a labourer, living close to Tibagy, produced a tiny bamboo stem, the open end of which was stuffed with a twisted leaf of milho; on extracting this, some small, but good Diamonds were found in the hollow stem. On pursuing this investigation further, most of the workmen's huts in the immediate neighbourhood were found to have some such stones hidden within them; but the gems were as a rule, small, hardly ever exceeding one carat in weight.

According to Prof. O. A. Derby, who examined the Tibagy Diamond-workings geologically, the gems appear to be derived from the Devonian sandstone through which the river flows; but the materials of the sandstone are themselves derived from metamorphic rocks. Gold is widely distributed through the Tibagy district, and the Diamonds, though usually small, are of good colour and great brilliancy. The author, some years ago, joined a syndicate to work the sands in the bed of the Tibagy, but though both Gold and Diamonds were found they did not occur in sufficient quantity to render the working remunerative, and the Tibagy Diamond fields were consequently abandoned.



BRAZILIAN DIAMOND in Matrix (Conglomerate).

The most important districts of the deposits of Diamond-bearing gravel in Brazil lie between 12 degs. and 26 degs. south latitude, including the Provinces of Minas-Geräes, Bahia, Goyaz, Mato Grosso, Parana and St. Paulo.

From the defiles of Itambé, the loftiest mountain of the chief Diamond district, the Copivary and Jequetinhonha, rich in Diamonds, take their rise. In the first of these a Diamond was found some years ago of about 9 carats weight. There occur in this district, in constant companionship with the Diamond, rounded fragments of clear transparent quartz, beside fragments of a very hard, red ironstone, and of black Lydian stone, varying from the size of a hazel nut to that of a pigeon's egg. The natives give to this last the name of " Feijao," from its likeness to the common black bean, and always hail its presence in the gravel with pleasure, as with it are found other precious stones beside the Diamond, such as white and blue Topaz Spinel, Garnet, and Lazulite. Beautiful specimens of Chrysoberyl are also found in the Diamond sands of Brazil, of yellow, parsley-green, and sky-blue colours.

With the Diamonds of Bahia is found an impure black, grey, or brown crystalline carbon, known in commerce as *Carbonado*, and highly valued for mounting in the steel drill-heads used for Diamond-boring—a purpose for which neither crystalline Diamond nor bort is applicable. This will be referred to at length in a subsequent chapter.

The supply of Diamonds was greatly increased in the early part of this century, by the discovery of new and richer mines in the province of Bahia, the stones of which are called in commerce *Bahias*. The yield from these mines, although considerable in quantity, is, however, defective in size, and inferior in average quality. The proportion of pure stones is less, and of the " off-coloured "

varieties greater, than is the produce of other mines; nevertheless, the exceptionally fine stones are as beautiful as any hitherto discovered elsewhere.

In 1772 the Government of Brazil first worked the Diamond mines on its own account. Rich as the fields were, the cost was enormous, and every carat weight of Diamonds cost the Government from fifteen to eighteen shillings.

The profit made in Minas-Geräes has been very considerable. In the first twenty years 144,000 carats of Diamonds were found annually. Up to 1850 this Province had yielded about 5,844,000 carats of Diamonds, valued at £9,000,000. If, in addition to this, we consider the contraband trade at the beginning of this century, estimated at £2,000,000, the worth of the Diamonds found in Minas-Geräes would be about £11,000,000. The Diamonds from these mines differ from those of the Bahia mines in shape and colour. The form of the stones is more regular, while the colour is more uniform in its greenish tints, and less, if at all, vitiated by any yellow reflection.

In the dry season of the year the Diamond-bearing sand is washed in large basins under water, until the practised eye discovers the stones. Formerly, as many as fourteen or fifteen Diamonds were often found in a single basin.

The Paraguay and its many tributaries carry down gold and Diamonds. During the dry season, from April to the middle of October, when the depth of the river is much diminished, the water is drawn off into a canal, and the mud of the river bed is dug out to a depth of six to ten feet, and carried to a place where it can be washed by the negroes during the wet season. In digging out the mud, large holes are often found containing many

Diamonds and much gold. When the wet season stops the digging, the scene of action is the "washing huts." Washing troughs (canoes) are placed side by side, and the overseer has a raised seat, so as to be able to observe all the negroes at work. Every trough has its little stream of water, and a negro keeps the contents in constant motion until the mud has been washed away and the water is quite clear. Then the sand and fine gravel are taken in the hand and searched for Diamonds. If one is found, the negro stands upright and knocks as a signal for the overseer, who takes the Diamond from him, and lays it in a vessel filled with water, which hangs in the middle of the shed. When the day's work is over, the contents of this vessel are taken by the overseer, and their weight entered in a book.

Large Diamonds are very rarely found. It has been estimated that in *ten thousand* specimens rarely more than *one* weighing *twenty* carats is met with, while possibly eight thousand of one carat, or less, may be discovered. At the works of the Jequetinhonha River, during a year's labour, only two or three stones have been found varying from seventeen to twenty carats, and in the whole of the works in Brazil, for the space of two years, not more than one of thirty carats was found. In 1851 a Diamond weighing 120⅝ carats was discovered at the source of the Patrocinho River, in the province of Minas-Geräes.

Somewhat later, on the Rio-das-Velhas, the labourers found a stone of 107 carats weight, and in Chapada one of 87½ carats. The largest, however, which has been discovered in Brazil is that called the "Star of the South," which was found in 1853, at Bogagem, in the Province of Minas-Geräes, and weighed 254½ carats before it was cut.

There are many laws and regulations in Brazil to

prevent the negroes concealing and smuggling Diamonds. As a means of encouraging honesty, if a negro finds a large stone, he is crowned with a wreath of flowers, led in procession to the manager, and formerly his freedom was bestowed upon him. If a negro finds a Diamond from eight to ten carats weight, he receives two new shirts, a suit of clothes a hat, and a handsome knife. For smaller, but valuable stones, other rewards are given.

For unfaithfulness the negroes are beaten with sticks, or have iron bands fastened round their throats; and on repetition of the fault they are not admitted to the works again. Notwithstanding all these rewards and punishments, one-third of the produce is supposed to be surreptitiously disposed of by the labourers. Manifold are the tricks used by the negroes to appropriate and barter the gems they discover. In the very presence of the overseers they manage to conceal them in their hair, their mouths, their ears, or between their fingers; it has been said that not unfrequently they will throw them away, and return for them at the dead of night.

The discovery of these Precious Stones in 1746 proved a great curse to the poor inhabitants on the banks of the Diamond rivers. Scarcely had the news of the discovery reached the Government ere they tried to secure the riches of these rivers for the Crown. To effect this the inhabitants were driven away from their homes to wild, far-away places, and deprived of their little possessions: Nature herself seemed to take part against them; for a dreadful drought, succeeded by a violent earthquake, increased their distress. Many of them perished, but those who lived to return were benevolently reinstated in their rightful possessions. Strange to say, on their return the earth seemed strewn with Diamonds. After a heavy shower the children

would find Diamonds in the streets and in the brooks which traversed them, and would often take home three or four carats of Diamonds. One negro found a Diamond at the root of a vegetable in his garden. Poultry, in picking up their food, swallowed Diamonds, so that their viscera required searching before being disposed of.

When Diamonds were first discovered in Bahia, the old capital of Brazil, which was at the time a densely-populated and fruitful province, the observant and intelligent Portuguese minister, the Marquis de Pombal, forbade further search, as he feared that agriculture, which he justly regarded as a source of blessing and health to the land, would suffer.

A very strange history is connected with the discovery of Diamonds in Bahia. An intelligent slave from Minas-Geräes, keeping his master's flocks in that province, thought he observed a similarity between the soil of his native place and that of Bahia. He sought therefore in the sand, and soon found 700 carats of Diamonds. Fleeing from his master he carried these with him, and offered them for sale in a distant city. Such wealth in the hands of a slave caused him to be arrested, but he would not betray himself. The master to whom he was given up tried to get at his secret by cunning, but without avail, until he thought of restoring to him his former occupation in Bahia, and watching him. As soon as the secret was known numbers flocked from Minas-Geräes and other parts of Brazil to Bahia, so that the following year as many as 25000 people were occupied in seeking Diamonds there, and the amount daily secured for some time rose to about 1,400 or 1,500 carats.

The number of Diamond-seekers however, gradually dwindled to between five and six thousand; but up to the

end of the year 1849 there had been as many as 932,400 carats of Diamonds obtained from the Chapada of Bahia. This rich field is about eighty miles long and forty miles broad.

The total produce from the entire Brazil Diamond districts was calculated up to the year 1850 to exceed 10,000,000 carats. In the year 1851 the produce appeared to be increasing; but in 1852 it was evidently on the wane.

The estimated value of Brazilian Diamonds from 1861 to 1867 was about £1,888,000. Some very interesting information was given by the German traveller, Herr von Tschudi, who visited the city of Diamantina, in February, 1858. He observes: "The pivot on which Diamantina turns is Diamonds. I was present during the unexampled commercial crisis which extended from town to town, and country to country, with such disastrous consequences, and which fell with the weight of an avalanche on the inhabitants of Diamantina. All business was stopped, and Diamonds fell to one-half the price they reached only the year before. I have taken much trouble to obtain an accurate statement of the present position (1859) of the Diamond trade in Brazil, and for that purpose have consulted the best authorities. The Diamonds of Brazil are known in commerce as (1) Diamantina Diamonds, and (2) Cincora Diamonds. The latter are of less value than the former, because they are not of such pure water, nor of so good a shape. In Matto Grosso the Diamonds are small, but of the purest water, and in their rough state have a peculiar lustre, which is seen in none other of the Bazilian Diamonds."

The panic described by Von Tschudi was severe, but it is very doubtful whether any panic was ever equal in

extent and importance to that caused by the discovery of the riches in South Africa, which caused a revolution in the Diamond market.

No country was more incredulous about the prodigious yield of the South African mines than Brazil, and this perversity made the loss disastrous to the Brazilian merchants, as they refused to receive the warnings which were sent them in perfect good faith. The favour bestowed on the Cape Diamonds, and the great margin of profit which they yielded, resulted in the Brazilian Diamonds being more and more neglected; and as the difficulties were augmented by the predilection of Amsterdam workmen for the new stones, a depreciation followed greater than that which the prices obtained for Cape stones justified.

The Cape yield of large stones, led to the general rejection of the small, such as were furnished by the Brazil merchants in every parcel which they supplied to the market. The alternative of sending only finer specimens to the practical exclusion of small stones, if they intended seriously to enter into competition with Cape gems, was a matter of anxious concern to them, not because the Brazilian Diamonds had deteriorated in beauty or in quality, but because the exorbitant price at which they had been offered for sale could no longer be maintained. It is a well-known fact that, owing to the increasing scarcity of stones, the working of the Brazilian mines gradually became barely remunerative; and at the present time it no longer pays to work for Diamonds in Brazil.

CHAPTER IV.

INDIAN DIAMONDS.

THE Diamond fields of India have been celebrated from remote antiquity. It is only of late years, however, that our knowledge of the geology of India has been sufficiently advanced to enable the mineralogist to speak with even approximate accuracy as to the nature of the Diamond-bearing rocks of that country. The materials accumulated by the Geological Survey have been rendered accessible to the public, by the issue of an admirable "Manual," of which the third volume is devoted to Economic Geology—a subject which Prof. V. Ball, formerly of the Geological Survey of India, has treated with great ability. A fourth volume, by Mr. F. R. Mallet, forms a kind of supplement to this work. The geological conditions under which the Diamond occurs in India are fully dealt with in this official Manual.

The Diamonds of India are generally found in superficial deposits derived from the disintegration of the solid rocks. Where the Diamond apparently occurs *in situ*, it is in certain rocks belonging to the great *Vindhyan formation*, a formation which derives its name from the

Vindyhan hills of the old geographers. No trace of life has yet been found in the Vindyhan rocks, and hence nothing can be said about their age, save that they are of very great geological antiquity. At the Panna mines, Diamonds have been found embedded in a conglomerate belonging to a minor division of the Upper Vindhyans, known as the *Rewar group;* but this conglomerate is apparently formed of materials derived from the older or Lower Vindhyan series. In Southern India the Lower Vindhyans are represented by the *Karnul group* and at the very base of this formation the Diamond is found. Such is its position, for example, at the Banaganpilly mines. But here again the Diamond rock is a conglomerate—that is to say, a detrital rock made up of pebbles derived from some yet older rock. Associated with these pebbles are the Diamonds ; but whence the Diamonds came, from what rock they may have been broken, or out of what matrix they may have been washed, no man can yet say. Old workings for Diamonds have been discovered in the *Dharwar Conglomerate,* of still higher antiquity than the Banaganpilly, but whether these workings yielded Diamonds, or not, is unknown. If Diamonds were worked in this conglomerate their origin is thrown back to an excessively remote period of geological time.

In 1882, M. Chaper, a French mining engineer, engaged in exploration for Diamonds in Madras, announced that he had discovered the Diamond in its veritable matrix near Wajra Karur, not far from Bellary. According to his reports, submitted to the French Academy of Sciences, and to the Geological Society of Paris, the rock which he regarded as the parent of the Diamond, was a rose-coloured Pegmatite. This is a granitic rock composed of pink orthoclase, or potash-felspar, pale oligoclase, or soda-lime

felspar, with quartz and epidote. From this rock he asserted that he obtained small Diamonds, associated with sapphires and rubies. This discovery, if verified, would be one of great scientific interest; but it is only fair to add that considerable doubt has been thrown by some of the officers of the Geological Survey on its authenticity.

Mr. Bruce Foote, a distinguished officer of the Indian Survey, has called attention to the occurrence near Wajra Karur of a certain rock, closely resembling, in his opinion, the famous "blue earth" of the South African Diamond fields. This "blue" forms a "neck" in a granitoid rock, containing epidote, and associated with hornblende gneiss; and it has been assumed that it represents an old and altered volcanic material, which has brought up the Indian Diamonds in a similar manner to that in which the Cape Diamonds have been carried up the volcanic ducts of Kimberley, by the olivine-bearing rock now altered to a serpentinous breccia. The analogy is ingenious, but as we believe no Diamonds have actually been found in the Wajra Karur rock, the suggestion is purely speculative. Even if the source of the Diamonds of Southern India could be attributed to volcanic rocks, rich in olivine, other explanations would have to be framed in order to satisfy the conditions presented by other Diamond-yielding localities in India.

The extent of Diamond-bearing alluvial deposits in India suggested to Karl Ritter a division of this formation into five groups, the geological conditions of which he carefully noticed. From his writings we select some passages. Thus, referring to Heyne and Voysey, Franklin and Adams, he says, "They are agreed that where there is a layer of alluvial soil it is superficial only, and to this is

mixed, or superadded, a conglomerate of rounded pebbles, together with a sandstone-breccia, which contains the Diamonds. Further, that the Diamonds are by no means scattered throughout this conglomerate, but occur only in one particular stratum, harder than the rest, and, at most, only one foot thick, and this is so throughout the whole of India wherever the Diamond is found. Voysey, who calls this rock a sandstone-breccia, says it lies under a firm sandstone bed, and consists of a fine mass of fragments of red and yellow Jasper, Quartz, Chalcedony, and Hornblende of different colours, bound together by a siliceous cement, which passes into a looser pudding-stone, with pebbles cemented with clay or marl, and this is characteristic of the Diamond-bed."

In the time of Mohammed Ghori, who in 1186 was the real founder of the Mohammedan dominion in India, the quantity of Diamonds discovered there was so great that he left in his treasury at his death Precious Stones to the weight of 400 lbs. It is reported he obtained them exclusively by plunder. Since the beginning of the thirteenth century these have been dispersed ; and at the finding of the celebrated stone called " The Great Mogul," Diamonds began to obtain a high price.

There are three extensive districts in India which have yielded Diamonds on a large scale. Of these the most famous is the southernmost improperly termed the Golconda region, the old fort of Golconda, in Hyderabad, being far distant. It includes various mines on the Kistna and Godaviri rivers, and other localities in the Madras Presidency, which will be noticed in detail in the following pages. The second great tract lies in the Central Provinces, and includes the mines of Sumbulpur. The third is in Bundelkhund, where are situated the Panna mines.

In addition to these principal areas, a few other localities have yielded Diamonds. They have been found, for example, in Bonai; in the province of Chutia Nagpur; and, it is said, near Simla.

An account of the Precious Stones of India has been given in a work entitled *Mani Málá*, by Rajah Sourindro Mohun Tagore, published at Calcutta, in 1879. Although some of the descriptions given are hardly scientific, yet the book contains much that is interesting with respect not only to the history of Precious Stones, but also as to their localities. The following list gives the names of the Indian localities in which the Diamond is said to occur, with the supposed modern equivalents of those names:—

1. Haima (Himalayas).
2. Mátanga (Kistna and Godaviri or Golconda).
3. Sauráshtra (Surat).
4. Paunda (probably included the Chutia Nagpur localities).
5. Kalinga (countries between Orissa and the Godaviri).
6. Kosala (the modern Ajodhya or Berar).
7. Vena Gangá (the Wemganga).
8. Saubira (the tract between the Sarhund and Indus rivers).

The most southern group of the Diamond strata begins at the environs of Cuddapah, or Kadapah, on the Pennar. Here for many hundred years Diamonds have been met with in various quantities. They are found in many places contiguous to each other: at Chennur or Chinon; at Cunnapurtee, opposite Chennur, probably the same locality as that described by Heyne and Newbold as Condapetta; at Woblapally or Obalumpally, at Vanniapenta. Ghunputty, Pinchetgapadu, Jummulmudgoo and

Connucaseloo; all being villages not far from the river Pennar.

Near Cuddapah (475 feet above the sea) the conglomerate is superficial, and from ten to twenty feet thick. The mountain rises 1,000 feet higher than this stratum, and its foot is everywhere covered with loose pebbles. The beds follow each other in the following order: uppermost a foot and a-half of sand, grit, and loam; then a tough blue or black muddy earth, without any stones, four feet thick; under this comes the Diamond bed, characterized by the numerous large round stones embedded in it. It is from two to two and a half feet thick, and consists of pebbles and grit, bound together by loam.

At Cuddapah large blocks of hornblendic rock, mostly derived from the neighbouring mountain chain, constitute the chief mass of the Diamond bed.

The Obalumpally mines, also on the right bank of the Pennar, are only a few hours' journey west of Cuddapah. The Diamond bed here seems to follow the course of the river, and is of varying width. Here the Diamonds always occur in more rounded crystals. Those found still further west are the best.

The villagers around the old Vanniapenta workings state that at a distant period, which they vaguely describe as about a hundred years ago, some "great people" came to the place and dug into a fissure in the blue limestone, whence they extracted a large quantity of Diamonds. Other pits were then dug in the neighbourhood, but none of them proved productive.

The Hindoos divide Diamonds into four classes, according to their castes. 1st, *Brahma*, clear and of "pure water." 2nd, *Chedra*, clear and of the colour of honey.

3rd, *Vysea*, cream-coloured. 4th, *Sudra*, a greyish-white. The Sudras are the Diamond seekers who carry on their work without inspection, and pride themselves on their honesty. The pits which they dig are square excavations, not more than sixteen feet deep.

Among the Diamond-bearing localities in the district round Bellary may be mentioned Wajra Karur, Gunjee-goonta, and Guti or Gutidrug.

The native village of Wajra Karur ("Diamond Town") is situated about nine miles from Goondacal, on the Madras Railway, in the Gooty Taluk. The Diamonds are found in the detritus covering the low county, and probably derived from the sandstones and breccias overlying the gneiss of the neighbouring hills. Diamonds have been found in the district from time immemorial, and Tippoo Sultan, when in power claimed all large stones, whilst he levied a royalty upon small ones. At the present time, the villagers turn out after heavy rains, and search for Diamonds.

In 1881 a Diamond of very fine quality, though of irregular shape, weighing in the rough 67⅜ carats, was found near Wajra Kurar, probably a little to the north-west of the village. This stone was purchased by Messrs. P. Orr and Sons, of Madras, and yielded a fine brilliant called the "Gor-do-Norr," Mr. Gordon Orr being the senior partner, whilst the name, spelt thus, chimed well with "Koh-i-nur."

It is said that the "Eugénie" Diamond was found by a poor peasant at Wajra Karur. He offered the stone to the village blacksmith, in return for repairing his plough, but the smith thought so little of its value that he flung the stone away. Afterwards, however, he picked it out of a heap of rubbish, to which he had consigned it, and

sold it for 6,000 rupees to Mr. Arathoon, a merchant in Madras, by whom it was disposed of, for a large sum to the Emperor Napoleon III.

In the *Philosophical Transactions* for 1677, there is an interesting paper to which Prof. V. Ball has called attention—a paper presented by the Earl Marshal of England to the Royal Society, in which it is stated that at the commencement of the seventeenth century a Portuguese gentleman went to Currure (Wajra Karur), and after much cost and labour obtained a large Diamond, believe to have weighed about 434 carats, which he sold at Goa. Prof. Ball has suggested that this stone may have been the Pitt Diamond, though the discovery goes back nearly a century before the famous Diamond figures in history, and is contrary to the general belief, which refers the discovery of the Pitt to the mines at Parteal. In like manner, Prof. Ball suggests that the great Mogul's Diamond may have come from Wajra Karur, notwithstanding Tavernier's statement that it was found at Kollur.

At the north end of the table-land, extending on the west side of the Nalla-Malla hills, as far as the town of Randial (672 feet above the level of the sea), lies another group of mines. The Diamond beds here are only about a foot thick, and both the over and underlying beds are more pebbly than in the first group.

Most of the Diamonds of this district lie loose in the *débris*. There is an erroneous impression among the poor miners that the Diamonds grow in and about the huge fragments of the crust of the earth which has been heaved and broken up. Among the natives of the Madras Presidency, there exists a curious belief that the rock-crystal, which occurs in the diamantiferous ground, will become Diamond when impregnated with electricity by the

action of lightning. Voysey found about these mines at least a dozen parties each consisting of seven or eight men, working in their own lot or particular heap. He describes them as mostly of the lowest class—poor, miserable creatures, with little government, and with no superintendent to direct or regulate their labour. In the rainy season the miners work in the Diamond pits on the heights, and when the floods are over, in the low-lying mines by Kistna. Most of the Indian Diamond miners belong to the aboriginal tribes, their trade being hereditary. The Panna mines were worked formerly by Gonds or Kols, and though some of the miners of Southern India are said to be Hindus, and others are simply described as low outcasts, yet they all probably are descended from the same Dravidian family.

The Diamond district of Banaganpilly lies five hours' journey west of Randial, surrounded by lofty plateaus, or flat-topped mountains, whose sides admit of cultivation. Heyne alleges that the mines are in the mountains, varying from one to two hundred feet in height, and that the Diamonds are found at a depth of about twenty feet from the surface. Voysey, who lived later than Heyne, asserts, in rectification of this statement, that, for many years past, it is only in the broken-up crust that the Diamonds are found.

Dr. King, the Director of the Geological Survey of India, visited these mines, and described the Diamond-layer as a clayey conglomerate containing pebbles and fragments of shale, chert, and quartzite. This "gangue is pounded up, mashed, sifted, and laid out to dry on prepared floors, after which the residue of clean sand is carefully examined in the hand by the women and children of the working parties, for the precious gems." These gems,

however, are evidently very rare, for Dr. King could not hear of a single stone being found during his stay of four or five days at the mines. Many other Diamond-bearing localities are known in the neighbourhood of Karnul, but in most cases the workings are now deserted.

In the valley of the Kistna, or Krishna, there are numerous spots in which Diamonds have been worked, especially at Kollur, which was probably the Gani Coulour of Tavernier; and at Parteal, or Gani Parteal. In fact, the localities in the Kistna and Godaviri valleys constitute the famous *Golconda district*, which, according to general belief, has yielded the great historical Diamonds of India. It must be distinctly understood, however, that no Diamonds have ever been found at Golconda itself. Golconda, the former capital of the district, was simply the commercial centre, where the Diamonds were brought and sold, and at the present day the only representative of the world-famed Golconda, is a deserted fort near Hyderabad.

When Tavernier visited the district in 1669, there were as many as twenty mines at work, but now nearly all have been forsaken, and even the names by which Tavernier knew them have become obsolete, and not without difficulty can their situations be identified. Prof. Ball in his excellent edition of Tavernier's *Travels*, published in 1889, has entered with much erudition, into a discussion of this subject. The most famous of these, named "Gani' by the natives, but "Colore" by the Persians, gave employment in Tavernier's time, to 60,000 workmen. Prof. Ball has brought forward strong evidence to shew that Tavernier's "Gani Coulour" is identical with the modern town of "Kolur" on the Kristna—the word *Gani* being equivalent to the Persian *Kan-i*, or "mine of;" so that "Gani Coulour" meant simply the "Mine of Coulour,"

just as "Gani Parteal" is the "Mine of Parteal.' Prof. Ball also seeks to identify Tavernier's famous locality of Raolconda, where the old traveller saw Diamond-cutting carried on in the mine itself, with the town now known as Ramulkota, about twenty miles south of Karnul, where the Diamond occurs in a matrix of pebble-conglomerate belonging to the Karnul series.

The Diamonds found at Gani Coulour were distinguished for their number and size; but, except in rare instances, they were deficient in purity and clearness. The largest and most celebrated found in this mine was that known as the "Great Mogul." In its rough state it weighed, according to Travernier, $787\frac{1}{2}$ carats, but was reduced by Hortensio Borgio, in cutting to $279\frac{9}{16}$ carats.

Tavernier also gives an account of the Diamond-mining operations at Coulour, and relates how a mine was discovered by a countryman, who, digging to sow some millet, found a pointed stone weighing about twenty-five carats. Not knowing what it was, he took it to Golconda, where he showed it to a trader in Diamonds, who, recognizing its value, enquired as to the locality where it was found. The report of a Diamond mine made a great sensation in the country, and the influential men of the town caused the ground to be worked. They were well rewarded for their trouble, by the discovery of large stones, averaging from ten to forty carats each, and sometimes even larger.

Within a few years of Tavernier's visit to the Diamond Mines, the district must have been visited by an unknown European (perhaps, as Prof. Ball suggests, Mr. Cholmley, who for some years purchased Diamonds for the East India Company) by whom a paper was sent to the Royal Society, and published in 1677, only one year after the appearance

of Tavernier's first edition. In this paper the writer mentions no fewer than 23 Diamond Mines in the kingdom of Golconda, and 15 in the kingdom of Bijapur, or Visapore.

The Mallivully Diamond Mines, between six and seven hours' journey W.S.W. of Ellora, were visited by Heyne in 1795. The plain, on which the villages round about Mallivully lie, is on all sides surrounded by granite rock. The average depth of the alluvium in which the Diamonds are found is twenty feet. This alluvial deposit extends along the banks of the Kistna for the distance of about two or three hours' walk.

The change from a grey to a red soil, consisting of weather-worn granitic gravel, is here distinctly seen. The upper layer consists of the black "Cotton soil" brought down from the higher grounds by floods. Beneath this layer lies a mass of fragments of sandstone, quartz, jasper, flint, and granite, with great amorphous masses of calcareous conglomerate, but destitute of any indication of their having been rolled there by water. It is in this stratum that the Diamond is found, together with other precious stones. None of the mines about Mallivully or Golapally are now worked.

The locality known as Parteal or Gani-Parteal, on the north bank of the Kistna, has been regarded by some authorities as the original home of many of the grandest historical stones, such as the "Koh-i-Nûr," and the famous "Pitt" or "Regent" Diamond. The Hyderabad (Deccan) Company has for some time past been washing for Diamonds at Parteal or Partial. So important were the Diamond-workings in this district that by the Treaty of 1766, made between the Nizam and the East India Company, they were reserved to His Highness. The Diamond fields of Hyderabad have recently been visited and reported

upon by several experts, namely, by Mr. Lowinsky in 1886, Mr. Theodore Hughes in 1887, and Mr. William Morgans in 1889.

The Diamond district of the Sumbulpur or Sambalpar group, in the Central Provinces, extends to the immediate vicinity of Sumbulpur, a city built on a fruitful alluvial table-land, 385 feet above the level of the sea, and situated between the rivers Mahanadi and Brahmini.

The Precious Stones which are found at the mouths of the little tributaries of the Maund, flowing from the north-east, are of various sizes and generally of the purest quality.

Although Diamonds are rarely, if ever, now found in Sumbulpur, it is interesting to preserve the description of the old Diamond-washers in the days of the Rajahs.

In Sumbulpur the Diamond seekers were of two castes. They resembled Negroes rather than Hindoos, and received the names of Ihara and Tora. Sixteen villages of the poorest kind were given up to them as free Jaghirs; ten being occupied by the Iharas and four by the Toras, the remaining two being dedicated to their gods.

These people were naturally superstitious. Nicolo Conti, who travelled in India in the early part of the 15th century, gives some very questionable stories as to a Diamond-producing mountain, and the means by which they were produced. It is also believed that sacrifices were made upon the opening of a new Diamond mine, and credulous travellers in those early days, might possibly have supposed that these sacrificial rites were essential to the successful search for Diamonds.

The Diamond seekers with their families, numbering from 4000 to 5000 persons, migrated yearly; and from November to the commencement of the rainy season

searched the bed of the Mahanadi River from Chunderpur to Sonepur, a distance of twenty-four miles, scrutinizing every cleft and corner for the Precious Stones. They carried with them only three tools, a pickaxe, a board five feet long, hollowed in the middle and provided with a raised border three inches high, and a second board about half the size of the other.

With the pickaxe they scraped the earth out of the clefts and holes, and piled it in heaps on the bank. Their women laid the earth on the larger board, slightly inclined, washed it with water, and removed all the rougher sand and pebbles, which were subsequently placed on the smaller board, spread out, and searched for precious stones and gold dust. The Diamond was found for the most part in a mass of tough, reddish clay, pebbles, a little sand, and some iron oxide. This seems to be the *débris* of the same stone "breccia" as that which Voysey supposed to be Diamond-rock in the Pennar and the Kistna groups. The washers of Sumbulpur now rarely, if ever, find Diamonds with the alluvial gold.

Another method of obtaining the Diamond was to form a flat surface in the neighbourhood of the place where the precious stones are to be sought, and build round it a wall two feet high, leaving here and there openings for the water to run off. The earth which had been worked out by means of the pickaxe, was thrown into this extemporized well, and after two or three washings the large stones were removed, the residue dried, and the Diamonds sought for. From time immemorial the Diamonds found in this district had been claimed by the ruler as his right. The finder of large Diamonds was rewarded by the royal grant of one or more small villages. For smaller Diamonds there were other rewards; but for the concealment of precious stones

the natives were punished by having their villages taken from them, and were subject also to corporal punishment. In spite of this, and threatenings of severer penalties, smuggling and concealment continued.

Since the year 1818, Sumbulpur has been under British rule. In that year a Diamond was found which weighed 21 carats, and although of only the third quality was sold for 5000 rupees.

It is necessary to distinguish *Sumbulpur* in the Central Provinces from Tavernier's *Soumelpour*, a locality identified by Prof. Ball with Semah or Semulpur, on the River Koel, in Chutia Nagpur. Diamonds have also been worked a little further south, at a locality on the South River, one of the tributaries to the Brahmani.

In the Chanda district, to the south east of Nagpur, are the old Diamond mines of Wariagarh

The Diamond-diggings in the immediate neighbourhood of Panna (or Punnah) in Bundelkhund, have been ably described by Mr. Medlicott, formerly Director of the Geological Survey of India. They do not cover an area of more than 20 acres. Great pits, 25 feet in diameter and, perhaps, 30 feet in depth, are dug for the sake of reaching the Diamond conglomerate, which, in many cases, is not more than a span in thickness. The miners enter the pit by means of inclined planes, and work almost naked and knee-deep in water. The material which they dig up is put into baskets and hauled by manual labour to the surface, where it is carefully searched for Diamonds. The most productive Diamond mines in this group were, in 1860, to be found in the village or Sukariuh, about twenty miles from Panna. Here the upper stratum, from 15 to 20 feet thick, had to be broken through in order to reach the rich Diamond-bed which lay concealed underneath.

Four kinds of Diamonds were found at Sukariuh. They were termed, 1st, *Motichul*, clear and brilliant; 2nd, *Manik*, verging in tint towards green; 3rd, *Panna*, with a faint orange tint; 4th, *Bunsput*, sepia coloured.

Diamonds are found under the cascade of the river Bagin, from 700 to 900 feet below the present Diamond strata; and the only explanation hitherto given is that the Bagin has brought these precious stones down from the table-land, with other matter torn from its native bed.

Diamond-mining in India under European management does not appear hitherto to have been successful. How far this is owing to the small scale on which the operations have been conducted, it is impossible to say It is, however, erroneous to suppose that there is any real exhaustion of the localities where mining is possible. On the contrary, geological examination has proved that the Diamond-bearing strata are very widely distributed; it is doubtful, however, whether the same working operations are carried on in the more remote districts as in those nearer home. In fact, Diamond-mining will never be a success in India until the Government is prepared to grant long leases for the working, so as to enable the capitalist to get back money spent in machinery, without which no mine can be properly worked. It is not to be expected that men will invest money without a prospect of recouping themselves.

Viewing it in the most favourable light, Diamond-mining cannot be considered as likely to offer a rapid road to fortune; nevertheless, for those who are contented with a slowly paying occupation and a hard life, it would no doubt be remunerative, provided the adventurer exercised close personal supervision and possessed a fair amount of capital.

CHAPTER V.

BORNEO DIAMONDS.

THERE can be no doubt that Diamonds are very widely distributed in the island of Borneo. Dr. Theodor Posewitz, a mining engineer, who resided there for nearly three years, published in Berlin, in 1889. a valuable work in which he discusses at great length the mineral resources of Borneo, and gives an interesting description of the occurrence and production of Diamonds. Much has also been written on the subjects in the reports of the Mining Department of the Dutch East Indies.

Extensive Diamond-fields exist in the rich gold-bearing district of Tanahlaut, especially near Martapura, in the south-east of Borneo. Kusan, in the east of the island, is also a district of much repute for both Diamonds and gold. But, perhaps, the most famous locality is Landak, in Western Borneo. Sangan, also in the west, likewise yields Diamonds, especially in the rivers Sikajam and Meran. Finally, the Sarawak River has, of late years been cited as a Diamond-yielding stream.

At all these localities the Diamonds are found with gold and, in some cases, with platinum, in the sands of the rivers; and also in beds of clay, sand and gravel, some-

times at a considerable depth. A blue or bluish-gray Corundum, known as *batu timahan*, is said to be a constant companion of the Diamond, the natives regarding it as an attendant on the " Prince," as they term the more precious stone. Verbeek thinks that the original matrix of the Diamond, which yielded the stones occurring in the drifts, is to be found among the older slaty and schistose rocks; whilst the late Carvill Lewis suggested that the Diamonds had been brought up from depths by the serpentine, or altered peridotite, which appears to be not uncommon in the Diamond districts of Borneo, as is the case in the South African fields.

The natives wash the sands of the rivers in small bowls, and become so expert in detecting the valuable stones that they can separate the Diamonds from the worthless minerals, even when so small as to escape observation by Europeans. The drifts are worked by means of small shafts sunk through the overlying deposits, and the Diamond-yielding bed is then followed by little tunnels driven in a very primitive manner. Considerable improvements have, however, been introduced by the Chinese, who are extremely skilful and economical miners. Of late years Europeans have entered the field, and Diamond-mines in Tjempaka are now worked by French engineers; but the washing of the Diamond-earth after its extraction is said to be still done on the old Malay system.

The Diamonds of Borneo usually occur in crystals presenting the form of the octahedron, the cube and the rhombic dodecahedron. If they present bright faces and sharp angles, and are considered by the natives to need no polishing, they are called *intan mendjadi.* The uncut Diamonds are called *podi;* the cut stones *intan.*

According to Posewitz the following varieties are distinguished:—

Intan Katja hitam, of bottle-green colour, and of great value.

Buntat intan, hard, dark and not to be cut: when spherical, they are called the "Soul of the Diamond," and are worn as amulets.

Intan-ajer-Laut, or Sea-water Diamonds, of pale blue colour.

Radja intan, or King of Diamonds; of red colour, very rare.

Intan minjak, brown Diamonds.

Chaping, triangular flat twin crystals.

The largest Borneo Diamond discovered of late years was found in 1865 at the diggings of M. Beretti at Tjempaka. It weighed in the rough 25 carats, and when cut 18½ carats.

A Diamond of 77 carats was found near Gunong Lawak, in South Borneo, and passed into the possession of the Sultan of Martapura. It is said that a Diamond weighing 70 carats known as "Segima," is the property of the Sultan of Matan. The so-called great Diamond of this Sultan, a stone known as the *Danau Radja*, with a reputed weight of 367 carats, was conclusively proved a few years ago to be only a piece of Rock-crystal, having a specific gravity of 2·63, and being scratched by corundum.

The art of cutting and polishing Diamonds has long been practised by the natives of Borneo, and is rather extensively carried on at Pontianak and Martapura. In the case of octahedral crystals, they simply rub down the solid angles at the top and bottom, and having polished these culets regard the work as complete, never

allowing the stone to lose weight by cutting facets on the sides.

Of late years the Diamond-industry of Borneo has suffered a serious decline. This is due partly to the fact that the superficial deposits have been mostly worked out, and the working of the drifts below is expensive and troublesome. The rulers, too, do but little to encourage Diamond working, as they claim all the large stones for themselves, and exact a royalty on the small ones. But the chief cause of the depression is, no doubt, traceable to the influx of Diamonds from South Africa, and consequent depreciation in the value of the Borneo stones. If, however, the deeper Diamond-drifts, which have as yet been scarcely touched, were systematically worked on a large scale by Europeans, with scientific appliances, there is reason to believe that the Diamond industry of Borneo might be successfully and profitably revived. It is very notable that Borneo has produced more beautifully coloured Diamonds of the rarer tints, such as red, green, and blue, than any other known country, and what is still more curious a smaller number of pale yellow and off-coloured stones.

CHAPTER VI.

AUSTRALIAN DIAMONDS.

ALTHOUGH three, at least, of our Australian Colonies have yielded Diamonds, it is only in New South Wales that they have been found in sufficient quantity to invite systematic exploration. As far back as the year 1851, Mr. E. H. Hargraves, in a report dated from Guyong, referred to some specimens of gold, and to a number of gems, including what he called, rather vaguely, "a small one of the Diamond kind," found in Reedy Creek, near Bathurst. But it was especially the late Rev. B. W. Clarke, a gentleman well-known for his researches in Australian geology, who first directed public attention to the Diamonds of New South Wales. Four specimens had been brought to him from the Macquarie river, near Suttor's Bar, in September, 1859, and a fifth, the following month, from Burrendong. In the meantime, he had received Diamonds from Pyramul and Calabash Creeks. These discoveries were considered by Mr. Clarke so significant, that he wrote a description of the occurrence, boldly heading it with the startling title, "New South Wales, a Diamond Country!" This announcement was not commercially justified till seven or eight years later, when the

gold rush occurred at the Two-mile flat, on the Cudgegong river, about nineteen miles north-west of Mudgee. The Cudgegong empties itself into the Macquarie, which is an affluent of the Darling. As soon as the gold diggers had set to work they detected Diamonds; and in July, 1869, operations were conducted by the Australian Diamond Mines' Company of Melbourne.

At the Mudgee workings, gems were found in an old river-drift, distributed in local patches, which appeared to be remnants of deposits once widely spread over the district, but now partially removed by denudation. These ancient river-gravels occur at various distances from the actual channel, and at elevations of forty feet or more above the level of the river. They are generally covered by a protective layer of basalt, sometimes columnar; and shafts have been sunk through the basaltic cap, so as to reach the under-lying Diamond-drift, which rests either on vertical strata or on massive greenstone. The gravels contain pebbles and boulders of Quartz, Tin-Stone, Rock-Crystal, Jasper, Agate, and other siliceous minerals, mixed with coarse sand and clay. Many of the boulders are remarkable for their peculiar polish. In some places the materials of the drift are united by a siliceous cement, into a compact mass, coloured pale-green by an iron silicate. Among the pebbles of the gravel, the diligent seeker may find many of the rarer minerals, including crystals of Topaz, Sapphire, Ruby, Zircon, Spinel, Garnet, and a peculiar variety of Pleonaste; and even this catalogue might be extended. But for present purposes it is only needful to add that two of the most prized substances in nature—Gold and the Diamond—are included. The Diamonds are sparsely and irregularly distributed through the gravels; but, nevertheless, when

large quantities of the drift are sifted and washed, the gems are brought to light, hardly, however, in sufficient numbers to pay for the working: as an example, during the first five months' washings no fewer than 2,500 Diamonds were picked out, but unfortunately, most of the stones were very small. The largest of the Mudgee Diamonds, a colourless octahedron, weighed but $5\frac{5}{8}$ carats: it was cut into a very fine white Brilliant of $3\frac{5}{16}$ carats, now the property of Mr. John de Pass.

These stones are found in a deposit of gravel, probably washed out of an older drift. Occasionally, they have been found in "water-holes" in the actual river-bed; but such discoveries may generally be attributed to "tailings" washed into the river at certain points from the gold diggings, and therefore the Diamonds may naturally be tracked back to the old drift. When found in the river-bed the stones are frequently scratched and fractured.

Within the last few years a Diamond-field has been opened up near Bingera, in New South Wales. This town is about 400 miles north of Sydney, on the River Horton, popularly known as the "Big River." How the Diamonds occur at this locality, has been well described by Professor Archibald Liversidge, F.R.S., of Sydney. The Diamond-bearing deposits are situated in a kind of basin, about four miles long and three miles wide, hemmed in by hills on all sides save on the north. An old river-drift, probably an ancient bed of the Horton, rests upon rocks of Devonian or of Carboniferous age, and is associated with basalt, by which it appears to be overlain. In some places the materials of the drift are compacted together into a conglomerate, so that the mode of occurrence of the Diamond at Bingera strikingly resembles that at

Mudgee. The minerals composing the gravels are also generally similar in the two cases, though points of difference are not wanting. One of the best indications of the presence of the Diamond, according to the Bingera miners, is a black Tourmaline, known locally as "Jet-stone." Some of the Diamonds are clear and colourless, others have a pale straw-tint: all are of small size, the largest yet known weighing about eight grains. According to an examination of some of the Bingera drift, by the Gwydir Diamond-mining Company, a ton of "stuff" yields on an average twenty Diamonds. Up to August 26th, 1873, the Eaglehawk claim had produced 1,680 Diamonds; but as the aggregate weighed only 803 grains troy, the very small size of the average stones is sufficiently apparent. The general weight of the Diamonds of New South Wales ranges from $\frac{1}{8}$ to $1\frac{1}{2}$ carat per stone.

Of late years the drifts in the tin-mining districts near Inverell have been found to contain Diamonds in quantity sufficient to invite systematic working, which has accordingly been prosecuted at the Bengonaway mine and elsewhere. At the Round Mount Diamond Mine in Auburn Vale, Inverell, 40 loads of "wash" yielded 1,500 Diamonds, weighing 500 carats; whilst 7 loads of wash yielded 408 Diamonds, weighing 101 carats. The Malacca Diamond and Tin-mining Company working also in Auburn Vale, near Inverell, reported that they had obtained up to May 1st, 1890, 2,650 carats of Diamonds. A new tunnel has recently been driven, and the first actual washing from the ground thus opened up yielded, from 507 loads of drift, as much as 2,183 carats of Diamonds, and 10 carats of Bort. The largest Diamond yet found in this mine has a weight of $3\frac{5}{8}$ carats.

The drifts of Vegetable Creek, in the New England district, have yielded great numbers of Diamonds; but, unfortunately, as elsewhere, of only small size. At the New Barca Diamond Mine, near Inverell, 60 loads of wash-dirt yielded 1,951 Diamonds, weighing 288 carats. It is reported that at the Pine Ridge Company's ground, near Inverell, 1,597 loads yielded 20,215 Diamonds weighing 3,637 carats. Mr. Gardiner Blackmore reported that in prospecting for Diamonds in the New England district, there had passed through his hands, in the course of twelve months, not fewer than 16,000 Diamonds, washed out of gem-drift, which had been regarded by the tin-miners as useless.

The Borah Tin and Diamond-mining Company obtained upwards of 200 Diamonds in the course of a few months from their mine near the junction of Cope's Creek with the Gwydir. Most of the stones were either of light straw colour or of very pale green tint. The largest weighed five grains. The Bengover Tin Mine, about two miles below the Borah workings, has yielded several Diamonds, including one of 7½ grains. A stone of 9 grains has been found at Bald Hill, Tambaroora Hill end. The old gold-workings at Mittagong, about 77 miles from Sydney, have yielded Diamonds of excellent quality, but of very small size. As other Diamond-bearing localities in New South Wales may be mentioned Wellington, Uralla and Coolah.

At the Mining Exhibition held at the Crystal Palace in 1890, Professor Liversidge, of Sydney, exhibited some interesting Diamonds from New South Wales, including a crystal from the Lachlan River, and a black Diamond from Mudgee.

Compared with the Diamond discoveries in New South

Wales, those of other parts of Australia sink into insignificance. South Australia is rich in mineral treasure; but this treasure mostly takes the form of ores of copper and iron. Yet the Colony is not without its gold-fields, and with the gold a few Diamonds have been found. In the year 1852, Diamonds were discovered in alluvial gold washings in the hills near Echunga, rather less than twenty miles south-east of Adelaide. It is said that more than a hundred Diamonds have at different times been found in this neighbourhood. Sir Arthur Blyth the Agent-General for South Australia, exhibited about twenty Diamonds from Echunga at the Paris Exhibition of 1878. One octahedral crystal weighed $5\frac{5}{16}$ carats, and another $3\frac{1}{2}$ carats. Mr. Dodd, who reported on them, called attention to their similarity in many respects to Brazilian Diamonds, and pointed out that they were found to be much harder than the Diamonds of South Africa.

Whilst Victoria is pre-eminently the "Golden Colony," and its gold-fields have for many years been actively explored, it is only now and then that a solitary Diamond has been found there. In 1862, the discovery of a Diamond in the Ovens district was announced by Mr. George Foord. It was a transparent yellow crystal, with perfect edges weighing about two grains. The Rev. J. J. Bleasdale, who has paid great attention to the study of Australian gems, described three Victorian Diamonds—two from Beechworth, and the third from Collingwood Flat. There appears, however, to have been some little doubt hanging over the reputed discoveries of Diamonds in Victoria; but in 1865 an Exhibition of Gems was held in the Hall of the Royal Society of Victoria, and from the specimens then exhibited and the information accompanying them, the matter was

set at rest. "The results of this exhibition," said Dr. Bleasdale, "have now placed this important truth beyond impeachment." Altogether about sixty Diamonds have been found in the Beechworth district, but they have not been of good colour, nor of large size, most of them weighing less than a carat each.

The first Australian Diamond ever brought to this country was presented by Sir Thomas Mitchell to the Museum of Practical Geology, in Jermyn Street, where it may now be seen. This small crystal weighs $\frac{3}{4}$ of a carat, and was found near Ophir, west of Bathurst, New South Wales.

To sum up our knowledge of Australian Diamonds: New South Wales, which is rich in coal, in oil shales, and in various carbonaceous products, is by no means poor in Diamonds, although those already discovered are, for the most part, extremely small; South Australia, with its vast wealth in copper and iron, possesses a limited Diamond-producing area; and Victoria, the great centre of the gold-fields, has furnished only an occasional Diamond as a mineralogical rarity. Queensland may yet come into prominence as a Diamond-yielding country. It is notable that Australian Diamonds are usually very difficult to cut and polish, in consequence of their knotty character. Whilst Diamonds from the Cape and elsewhere offer no difficulty, the operation of polishing proceeding as smoothly as though it were the planing of a piece of wood, the knots of the Australian Diamonds cause them to catch in the polishing wheel, and the workmen consequently object to polishing them This difficulty, however, could probably be overcome, if the stones were large enough to render the work remunerative; but whilst African Diamonds of large size come freely into the market the small Diamonds of Australia are not likely to find favour.

CHAPTER VII.

THE DIAMONDS OF THE UNITED STATES.

ALTHOUGH it has long been known that Diamonds occur in the United States, and fresh discoveries are from time to time reported, some of which are undoubtedly authentic, yet the quantity and the character of the stones hitherto found have not been such as to warrant any attempts at systematic working. The Diamonds occur mostly in the auriferous sands and gravels, and have been accidentally brought to light in washing the detritus for its gold.

In the Eastern States, Diamonds have been found very sparsely distributed through a belt of metamorphic rocks, along the east of the Appalachians, stretching through the States of Virginia, the Carolinas, and Georgia; whilst in the West they are said to occur in California, Oregon and Idaho. A comprehensive review of the general subject has been published by Mr. G. F. Kunz, of New York, in his work on "The Gems and Precious Stones of the United States" (1890).

Perhaps the most noteworthy Diamond hitherto yielded by the United States was one discovered, in 1855 at Manchester, opposite Richmond, in the State of Virginia. It was found by a labourer at work in one of the streets, and was submitted by him to Mr. J. H. Tyler,

sen., of Richmond, who at once pronounced it to be a valuable stone. It presented the form of an octahedron, with only a single small black spot in one of the solid angles, but it was off-coloured. In the rough it weighed $23\frac{3}{4}$ carats, and after cutting weighed upwards of $11\frac{11}{16}$ carats. This stone has been called, after some of its owners, the "Dewey Diamond" and the "Morrissey Diamond."

The occurrence of itacolumite, or flexible sandstone, in North Carolina, led at one time to the conclusion that Diamonds might be found plentifully in that State, since it was believed by many mineralogists that a similar rock formed the matrix of the Diamond in Brazil.

One of the most prolific localities in the West has been the Cherokee District, in Butte County, California, where the gold miners on cleaning up the sluices occasionally find Diamonds. The stones are associated, as pointed out by the late Professor Silliman, with several rare minerals, including platinum.

About the year 1870, large discoveries of Diamonds were reported from Arizona, but it was eventually found that a gigantic fraud had been perpetrated, the ground having been liberally "salted" with rough Diamonds and other precious stones, such as Rubies and Sapphires, purchased in England for that purpose.

Since the preceding chapters on Diamonds have been written, reports have reached this country of the occurrence of small Diamonds in a mass of meteoric iron, brought from Arizona by Professor Foote.

CHAPTER VIII.

COLOURED DIAMONDS.

DIAMONDS occur of every hue, and according to Maundeville, "seem to take pleasure in assuming in turn the colours proper to other gems." The Blue or Sapphire tint is, with the exception of the Ruby Red, the rarest of colours met with in Diamonds.

The following is the order in which coloured Diamonds may be ranked, having regard to their rarity and value :—1, Red ; 2, Green ; 3, Blue. There are undoubtedly fine specimens not included in this classification ; their tints and shades being so peculiar and varied that they may better be described individually than in groups.

RED DIAMONDS.

The true Red Diamond is valuable "according to the glorious beauty of its perfection ;" to use a quaint phrase of good old Thomas Nicols, writing to the dons of Cambridge in 1651. "It feeds your eyes with much pleasure in beholding, and hence are discovered to us the excellencies of super-celestial things."

Almost the only specimen known to jewellers is a gem of a carat weight, bought by the author, and now in the possession of a great connoisseur. It is known as the "Halphen Red Diamond." For richness of colour it may not inaptly be likened to an African sunset.

There are many Rose-coloured Diamonds, but the Blood or Ruby Red specimen just described—a gem on fire as it were—is believed to be unique in all modern experience. I understand, however, that a fine Red Diamond has lately been found in Borneo, and sold, for a large sum, in Paris.

GREEN DIAMONDS.

The history of the finest specimen of a Diamond of this colour may not be uninteresting. Thirty years ago this stone was thrown out of a parcel of Emeralds in Vienna and bought for a trifle by Mr. George Samuel, the Consul there, who sold it to the author for £200. Some years afterwards, it was sold for £300. Subsequently it passed into the possession of a jeweller in Bond Street, who sold it to an American for £600, and afterwards £1,000 was offered for it, but refused.

Among the treasures of the famous Grüne Gewölbe, or "Green Vaults," of Dresden, is a faded Green Diamond weighing 48½ carats, and valued at £30,000. It is not, however, to be compared, in respect of colour, with the one mentioned above.

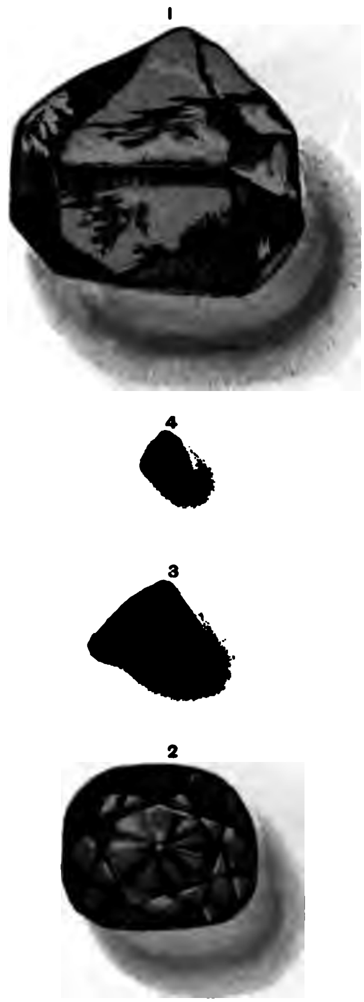
The collection of coloured Diamonds in the Vienna Museum, which was brought together by Herr Virgil von Helmreicher, a Tryolese by birth, but long resident in Brazil, is undoubtedly the most complete in Europe.

BLUE DIAMONDS.

Diamonds of a faint bluish tint are not unfrequently found, but their defect is that they are usually more or less opalescent, and therefore rank as stones of inferior quality.

Although writers describe these stones as possessing in an eminent degree the beauty of fine Sapphires, no comparison can really be instituted, their blue colour being peculiar to themselves—dark, verging on indigo, possessing a characteristic intensity which differs materially from the mild, soft hue of the Sapphire; and, above all, they possess the exclusive irradiance technically described as the "fire" of the Brilliant. It is indeed a gem which, for its intrinsic beauty, no less than for its extreme rarity, almost challenges the foremost place among "Precious Stones."

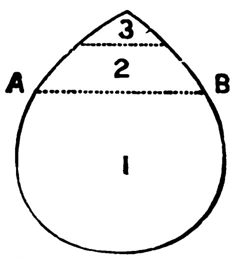
The only Blue Diamonds known until lately were found in the old Indian mines, probably those of Gani-Colour, visited by Tavernier, and the first mention we have of a Blue Diamond in Europe refers to a stone then considered unique. It weighed in the rough 112¼ carats, was bought by Tavernier in India in 1642, and was sold to Louis XIV. in 1668. It is described as "d'un beau violet." It would appear to have been somewhat flat and ill-formed. The figure in the plate opposite probably represents faithfully this stone in its then condition, and is a copy from an old French engraving. After its purchase by "Le Grand Monarque," it was apparently cut. It figured in a grand historic scene on the 19th February, 1715, when the Persian Ambassador appeared before Louis XIV., twelve days after his public entry into Paris. Le Grand Monarque, notwithstanding his great age and infirmities, exerted his remaining energy of will to appear before the illustrious stranger to the best



1. TAVERNIER INDIAN ROUGH BLUE DIAMOND. 3. THE "BRUNSWICK" BLUE DIAMOND (Rose Cu
2. THE "HOPE" BLUE DIAMOND (Brilliant Cut). 4. THE "PIRIE" BLUE DIAMOND (Brilliant Cu

2, 3, 4. Cut from French Blue Brilliant.

bable. This deduction is indeed the more plausible, as Tavernier's Diamond evidently had one of the crystallographic faces *largely produced* on the one side, which gave the stone a "drop form," a formation frequently seen in rough Diamonds. especially in coloured stones (excepting always the yellow varieties), and leading to the inference that the cleavage plane must have lain as in the diagram betweeen A and B. In the first cutting of the stone this original shape was to some extent preserved, which left an ill-formed, triangular-shaped Brilliant somewhat thin on one side. From this it would have been easy for an expert to cleave a triangular piece of about 10 or 11 carats, thus leaving the stone weighing about 56 carats, the re-cutting of which, as a perfect Brilliant, well proportioned, would reduce it to its present weight of 44¼ carats. It is observable that the "Hope" Diamond is even now straighter on one side than the other, and this strengthens the presumption of the stone having been cleaved as suggested.



(See Coloured Plate of Blue Diamond for shapes).

The correctness of this hypothesis would receive confirmation if the pieces, or the piece, assumed to be split off could be discovered and identified, but the difficulty in the way of this evidence lies in the strong presumption of *remanets* having been also subjected to re-cutting and re-polishing. The cleft-off piece must have been triangular at first, with a straight side corresponding with the side of the "Hope" Diamond, as shewn in the diagram. After being re-cut it would make a Blue Diamond of "drop shape," the base of which would correspond with the straight side of the latter gem, proportionate

in substance, identical in colour (in all probability), and weighing from 6 to 7 carats.

A stone answering to such a description would supply strong presumptive evidence in support of the theory, that the two stones would be part of the one originally separated by the cleaver's art; and such a stone did actually come into the market in the April of 1874, and fell into the hands of some competent judges, who examined it in juxtaposition with the "Hope" Diamond, to which, in colour and quality, it bore a remarkable resemblance. It was purchased in Geneva at the sale of the late Duke of Brunswick's jewels. The conclusion that the Duke of Brunswick's "Blue Drop Diamond" once formed the projecting side which appears to have characterized the original shape of the "Hope" Brilliant was inevitable, and the author bought the third piece in Paris for £300; it weighed 1 carat, and was of identically the same colour, thus quite accounting for the Blue Diamond stolen in 1792. This will be understood by reference to the figure on p. 137.

CHAPTER IX.

BORT AND CARBONADO.

BORT.

CERTAIN Diamonds are found of inferior quality, and so imperfectly crystallized, that they are useless as ornamental stones. These are called "Bort," or "Boort," and are either crushed to form Diamond dust, or are used for engraving. By mineralogists the name *Bort* is restricted to a form of Diamond; which generally presents the appearance of small nodules or spherical masses, rough on the outside, and destitute of cleavage, but displaying on fracture a radiated internal structure. It is usually greyish-white, or of a dark or even black colour, and has a density a trifle less, but a hardness decidedly higher, than that of ordinary Diamond. Under the microscope it shews a confusedly crystalline structure. Useless for the purpose of the jeweller, it is consigned to the lapidary to be crushed in steel mortars and used in the form of powder as an abrading agent. The Diamond powder formed by crushing these inferior stones, as well as that which is the produce of the operations of cutting and cleaving rough

stones, is, after mixture with oil, employed for polishing Diamonds, Rubies, Sapphires, and other gems. The rough Diamond is also used for dressing millstones and other purposes.

CARBONADO.

This substance, also known as "*Carbonate*" or "*Carbon*," was discovered in Brazil in 1845, and occurs in small irregular masses of a dark grey, or even black colour. Both the names, Carbonado and Carbonate, are clearly misnomers, as, chemically, the body referred to is like Diamond, Graphite and Charcoal, a form of the element Carbon. It appears to consist of an irregular aggregate of small crystals, and presents on fracture a granular or crypto-crystalline structure. It is found in Brazil, mostly at Chapada, in the province of Bahia; and in the island of Borneo; but has not been found either in India or at the Cape. Carbonado though of slightly less density than the ordinary Diamond, is immensely superior to it in hardness. It is, in truth, the hardest known substance in nature, surpassing even Bort, which, in its best varieties is a trifle harder than the Diamond.

Carbonado was at first introduced for the purpose of cutting Diamonds, after the same fashion as Bort. Of late years, however, a new and most important application of this material has been made. It is employed for the purpose of drilling holes in rocks, either to receive explosives for subsequent blasting, or for prospecting, in order to discover their underlying strata. The demand that has thus sprung up for Carbonado,

has caused it to rise in price from 1*s.* to about 50*s.* per carat. If steel is used to cut rocks, a percussive and not a rubbing or cutting motion must be given to it; otherwise, owing to its deficient hardness, the steel itself would be worn away rather than the rock, as is popularly exemplified in the ordinary grindstone. Where deep borings for exploring purposes have to be made, it becomes a difficult mechanical problem to construct a machine, which shall satisfactorily impart a striking motion to a heavy steel tool. Moreover, the difficulties and chances of failure increase very rapidly with the distance from the surface, whereas, with a continuous rotatory motion, it is comparatively easy to bore to any depth. Borings have been effected to a depth of several thousand feet with the aid of carbon, not much greater difficulty being experienced at the end than at the commencement of the operations

Selected pieces of carbon are firmly embedded in a ring of steel, called a crown, of the size corresponding to that of the perforation which it is desired to bore. This ring is screwed to a series of long hollow tubes, which are lengthened as the work proceeds; these tubes or rods are kept rotating by steam power, and their weight is so adjusted, that a pressure of half a ton can be brought to bear on the crown, when it is boring a 4-in. hole in native or living rock. The crown rotates some 250 times a minute, and water is continually pumped through the hollow rods, passing under the cutting face of the crown, to keep the Diamonds cool, and to wash off and upward to the surface, the *débris* formed by the action of the crown. Under favourable circumstances, hard granite would be readily cut at the rate of from 3 in. to 4 in. per minute.

The Diamond apparatus does its work entirely by friction. Its action is simply an abrading one, and effected neither by cutting nor percussion. It grinds or crushes the rocky stratum by its adamantine density. The difference between the relative hardness of the Carbonate and ordinary rock is such, that several thousand feet might be bored with a crown properly set with good stones, before any serious wear would take place. The principal loss does not result from actual wear, but from the breakage which is caused when one of the stones becomes loose in its setting, or from some accidental cleavage which occurs; the fragments, unable to escape from beneath the crown, invariably injure the other stones.

CHAPTER X.

VALUE OF ROUGH DIAMONDS.

THE valuing of rough Diamonds requires much technical experience.

Although the Diamonds of all parts of the world possess certain characteristics in common, yet the stones from different places have special peculiarities by which good judges generally find themselves at once in a position to declare the locality whence they have been obtained, although they cannot always define the grounds of their judgment.

In valuing rough Diamonds it is necessary to consider the following points: firstly, the form and proportions of the crystal, whether it can be cleaved to advantage; and then the loss of weight likely to be incurred in cutting, as an irregular or broken piece obviously requires a greater sacrifice of weight to form it into a perfect Brilliant than a well-proportioned crystal. The best forms to choose are the octahedron and the rhombic-dodecahedron. Chips or splints are often fashioned by the cutter with very little loss of weight. Secondly, heed must be taken to distinguish the degrees of colour, and purity of the specimen.

It must not be forgotten, in estimating large Rough Diamonds, especially those from the Cape, that certain

tints of colour may be brought out in the cutting, which do not appear in the stone in its rough state; thus, perfect polish, and the power of reflection, characteristic of the Brilliant, intensify any tint of yellow existing in the stone. This observation does not apply to river stones, but rather to those from the dry diggings. In many specimens a black spot is developed after cutting, which was not visible in the rough. This spot may appear even in the finest Diamonds, and is especially noticeable in Indian stones.

It is impossible, to quote a standard price for Rough Diamonds since the price is subject to much fluctuation. The remark universally applicable is that the value varies greatly, according to the size and quality of the stone.

Cape Rough Diamonds.

To those who are not conversant with the various classes and details of the subdivision of Rough Diamonds, the following classification may be of service:—

White Clear Crystals.
Bright Black Cleavage.
Cape White.
Light Bywater.
Large White Cleavage.
Picked Melée.
Common and Ordinary Melée.
Bultfontein Melée.
Large White Chips.
Small White Chips.
Mackel or Macle (flat for roses).
Bright Brown.
Deep Brown.
Bort.
Yellows.
Large Yellows and Large Bywaters.
Fine Quality River Stones.
Jagersfontein Stones.
Splints.
Emden.
Fine Fancy Stones.

SECTION III.

COLOURED STONES.

CHAPTER I.

THE RUBY.

THE Ruby not only stands in the very foremost class of coloured gems, but it occupies among Precious Stones in general a position which is unquestionably supreme. By the Ancients it was regarded as the very type of all that was most precious in the natural world; and its value is amply attested by the numerous allusions to it in the Old Testament.

Although it is not always easy to distinguish in ancient writings between the description of the Ruby and that of other red stones, it is yet believed that the *Anthrax* of the Greek Philosopher Theophrastus must have been the mineral which we recognise as Ruby; whilst the *Carbunculus* of Pliny probably included this and other stones of a somewhat similar character. The Anthrax was so called in allusion to its vivid colour, suggestive of that of a live coal, and the word Carbunculus likewise referred to its fiery appearance. Of the various kinds of Carbunculus known to the Ancients, the most valuable

was that termed *Lychnis*, in consequence of its lustre resembling that of a lamp. It is curious to note that many old writers seem to have believed in the self-luminosity of the Ruby and other red stones. Thus, the quaint old writer Sir John Maundeville, describing his travels in the East in the fourteenth century, says with regard to the many marvels of the Court of the Great Chan of Cathay, "This Emperor hath in his chamber, in one of the pillars of gold, a Ruby and a Carbuncle of half a foot long, which in the night gives so much light and shining, that it is as light as day." This statement, however, may be laid to rest with the numerous other travellers' stories to be found in the pages of the credulous old Knight.

Before Mineralogy became a science, and could call to its aid the services of Chemistry and Physics, it was by no means surprising that various stones of red colour should be confounded together: thus the Spinel or Balas, and the Garnet were often mistaken for the true Ruby. The only stone, however, to which the term Ruby can in scientific strictness be applied is a variety of the mineral-species termed *Corundum*.

The name Corundum is derived from the Hindu word *Kurand*, and it is most probable that it first became known in Europe from the stone having been imported from India. Corundum occurs in a great variety of conditions, some being coarse and opaque, while others are translucent or transparent, but it is only the latter which take rank as gem-stones.

All forms of Corundum, are found by the chemist to contain more than half their weight of that peculiar metal, which is now widely known under the name of *Aluminium*. This beautiful metal much resembles silver in colour and lustre but is widely different from silver in its extreme

lightness. The oxide of this metal is called *Alumina*, and it is this substance which, in its natural state, forms the mineral Corundum. As a silicate, Alumina forms the basis of all clays, and a multitude of other common minerals and rocks; while as a sulphate it enters into the composition of *Alum*—whence indeed the word "Alumina" is derived.

The coarser varieties of Corundum are more or less impure, but the transparent crystals exhibit the Alumina in a state of approximate purity—being uncontaminated with any other substance, save perhaps a trace of certain metallic oxides, on which the exquisite tints of the coloured Corundums depend, but which are present in such minute quantity as well-nigh to elude the vigilance of the chemist.

Those Corundums which present a red or reddish colour are the true Ruby—this stone being sometimes described in works on mineralogy as the *Oriental Ruby*, in order to distinguish it from such stones as the Spinel and others. The main fact to be borne in mind with respect to the distinctive character of the Ruby, from a Mineralogist's point of view, is that it is really *a variety of crystallized Alumina.* It will be shewn in a subsequent part of this work that the Sapphire has practically the same chemical composition and the same physical characters, the difference between these stones being mainly one of colour. It is believed that the fine colour of the Ruby is due to the presence of oxide of chromium, associated in very small proportion with the alumina.

When Tavernier in his famous "Travels" describes the Ruby of Pegu, he says: "All other coloured stones in this country are called by the name *Ruby*, and are only distinguished by colour; thus, in the language of Pegu, the sapphire is a Blue Ruby," &c. With reference to this

passage, Professor Valentine Ball, of Dublin, in his admirable edition of the "Travels," remarks in a note: "A very legitimate system of nomenclature, as they are all of the same chemical composition, viz.: alumina or corundum."

Corundum, in all its varieties, crystallizes in the hexagonal system, usually in double six-sided pyramids, but often also in hexagonal prisms, and sometimes in six-sided plates or tabular crystals. The crystalline character of the Ruby furnishes, even in a cut stone, a ready means of distinguishing it from Garnet or from Spinel; since the crystalline structure is closely correlated with certain optical properties. The use of the instrument called the *dichroiscope* renders the distinction a matter of certainty. This instrument enables us to see whether the gem possesses the property of dichroism—that is, of exhibiting two distinct colours, or tints, when viewed in different directions. Gems belonging to the Cubic system of crystallization do *not* exhibit this property, while in those belonging to any of the other systems this diversity may often be detected, when properly examined by the dichroiscope, be the stone ever so perfect and uniform in colour to the unassisted eye. Since both the Spinel and the Garnet belong to the Cubic or Tesseral system, they display *no* dichroism, whereas the Ruby, which belongs to the Hexagonal system, is invariably dichroic. The typical Ruby when examined by the dichroiscope, exhibits one image of an aurora-red colour, while the other is carmine.

The crystals of Corundum, including those of Ruby and Sapphire, are often ill-shaped and rough, and usually much rolled. The cleavage is accompanied by conchoidal and uneven fracture, and by brittleness. The lustre of Corundum is vitreous, but sometimes pearly on the basal planes, and the crystals, when properly cut, occasionally

exhibit a bright opalescent star of six rays in the direction of the principal axis. Such crystals form the *Star Stones*, to be noticed in a subsequent chapter.

The refractive index of Corundum is 1·77, and therefore higher than that of glass; hence the great brilliancy of the Corundum gem-stones, when properly cut and polished. Mr. Crookes has shown that the Ruby, when exposed to electric discharge in high vacuo, phosphoresces with a brilliant red glow.

All varieties of Corundum can be scratched by the Diamond, but by no other mineral. The extreme hardness of Corundum has suggested its mineralogical name of *Adamantine Spar;* and it seems likely that the *Adamas* of early Greek writers was not the true Diamond, but merely a form of Corundum.

Although Corundum is a mineral which, in its various forms, enjoys a fairly wide geographical distribution it is remarkable that the fine red varieties are extremely rare and restricted in their occurrence. The localities yielding the Rubies of commerce are indeed practically limited to Burma, Siam and Ceylon. Even of these localities, it is only Burma that has acquired celebrity for the favourite tint, the true pigeon's-blood colour; those of Siam being generally too dark, and those of Ceylon too pale, to satisfy the connoisseur, though in both places a fine gem is occasionally found.

BURMA RUBIES.

It seems highly probable that all the finest Rubies in the world have been derived, either directly or indirectly, from Upper Burma. Although the Burmese mines have been worked for centuries, they were so jealously guarded

that Europeans have only quite recently been able to ascertain the precise conditions under which the Rubies occur. Ava, the old capital, afterwards superseded by Mandalay, was known officially as Ratanapura, or "City of Gems"—a name sufficiently suggestive of the trade in precious stones; yet until lately the very position of the Ruby mines was but imperfectly known, and the most erroneous data were supplied by our scientific treatises. It is curious to note, for example, the geographical confusion in such a work as Phillips's "Mineralogy," a standard treatise in the early part of this century, where we are told that Rubies are found in "the Capelan mountains, 12 days' journey from Sirian, a city of Pegu, in Ceylon!"

Colonel Symes, who was sent by the Governor-General of India on a mission to the Court of Ava at the close of the last century, and again at the beginning of this, brought home from his first journey a magnificent specinen of so-called Rubellite, or red tourmaline, together with certain Rubies and Sapphires. But the work in which he tells the story of his mission contains only the most meagre references to the localities of these precious stones.

Mr. John Crawfurd, who went on an embassy to Ava in the years 1826 and 1827, has much more to say about the Rubies of the country. He tells us that "the king lays claim to every Ruby and Sapphire which exceeds the value of 100 ticals; and there is, from all accounts, a large collection of both in the Royal Treasury." With reference to this statement it may be pointed out that the Treasure from the Royal Palace at Mandalay, now exhibited at the India Museum, South Kensington, contains a large number of Rubies in the Regalia, but they are mostly of only small size, or, if large, of imperfect quality. No doubt King Theebaw, when dethroned by the English, managed to

carry with him into exile some of the most precious of his jewels, or to bury them somewhere unknown to us.

"While I was in Ava," wrote Mr. Crawfurd, "two stones partaking equally of the Sapphire and the Ruby, were brought to me for sale. One of them, the property of the Queen's brother, was a very fine gem, without a flaw, the red and blue colour nearly dividing it into two equal and distinct parts." The author had one weighing 20 carats, oval in shape, where the Red and Blue were divided into equal parts. These parti-coloured stones are of interest as supporting the statement previously made in this chapter to the effect that the Ruby and the Sapphire are really the same mineral, save only in colour.

In another passage, Crawfurd gives a striking illustration of the jealousy with which the Burmese Government regarded its right to all the Precious Stones of signal value found within the range of the Burmese Empire. He states that in the vicinity of the Aracan Temple "We called at the house of an Armenian to see some Rubies and Sapphires. The owner produced some of small size which we purchased, when he told us in confidence that he dared not produce any larger ones then, but as we were on our travels he would meet us at Rangoon and show us some much finer, as any Ruby worth over £70 being considered the property of the King, the exposure, or even the possession, of one beyond that value was a crime punishable by fine and confiscation." In order to avoid this penalty and loss of property, the discoverer of a large stone was often tempted to break it into pieces.

It was thought that when Pegu, the "Fatherland of Rubies," was annexed to England in 1852, Europe would be richer in these beautiful stones, but this was not the case. Some time after the war, a mission was sent to the

Court of Ava. Attached to this mission was the late Dr. Thomas Oldham, the Director of the Geological Survey of India, who was extremely anxious to visit the Ruby mines. The king, however, put every obstacle in his way, assuring him "that people going there at this season [September], are sure to die." Although Dr. Oldham failed in his object to visit the mines he obtained much valuable information regarding the general geology of Burma, which he published in the form of an Appendix to the late Colonel Sir H. Yule's well-known "Narrative."

Up to the time of the annexation of Upper Burma in 1886 to the British Empire, no description of the Ruby district had been written by an Englishman; and the only accessible account of the mines was one by the Padre Guiseppe d'Amato, an Italian Jesuit Missionary in Burma, whose description was published in the "Journal of the Asiatic Society of Bengal," for 1833.

Within the last five years, however, our knowledge of the subject has grown rapidly, and at present we are in possession of so large a body of information respecting the character of the country and the working of the mines that the two succeeding chapters of this work will be devoted to these subjects. It is therefore, unnecessary in the present place to enter into full details.

From enquiries made on the spot in 1888 by Mr. F. Atlay, who was for some time the author's representative at the mines, and is now the local sub-manager for the Burma Ruby Mines Company, it appears that there is a tradition to the effect that the Ruby-tract, including Mogok, Kathe and Kyat-pyin, formerly belonged to Momeit; and that the Burmese at that time knew nothing about the occurrence of Rubies. It happened in the year 1630 that a Burman came to Mogok with tamarinds for

CRYSTAL OF WHITE CAPE DIAMOND.

BURMA RUBY.
(Weight, 1184 Carats.)

sale; and having obtained a red stone in exchange for some of his fruit, presented this to the King of Ava. The king was so pleased with the Ruby that he entered into negotiations for the tract of country which produced such minerals; and in the year 1637, he peacefully obtained the Ruby district in exchange for other territory.

Although no systematic geological survey has yet been officially made of the Ruby mining district, it appears to consist of gneiss and other metamorphic rocks, associated with beds of crystalline limestone, containing calc-spar. This spar, or calcite, which is frequently of bluish tint, and always shews well-developed rhombohedral cleavage-planes, contains crystals of Ruby, Spinel and other minerals. Whether the calc-spar or the limestone, or some of the associated gneissose and granitic rocks, formed the veritable matrix—the true mother rock—in which the Rubies were originally developed, is a geological question which we are, as yet, hardly in a position to decide.

By the disintegration of the matrix, the Rubies and Spinels have been set free; and are now largely found, as rolled crystals and derivative fragments, among the detrital matter which is abundantly distributed over the valleys, along the hill-sides, and on the floor of the limestone-caverns. A brown or yellowish clay, known locally as *Byon*, seems to be the typical Ruby-bearing earth.

Since the district has been worked by Europeans—first by the author, and now by the present Mining Company—large numbers of Rubies have been found, but mostly of small size and of no great value. Three large masses were, however, recently put up for sale, on behalf of the Company, by Messrs. Christie, but they were, unfortunately, not of fine colour, nor were they sufficiently transparent to be advantageously cut as gems; and they were consequently not sold.

In 1887, when working the mines, and before the Company was formed, the author obtained from Burma a curious rough Ruby weighing 49 carats, and consisting of a flattened aggregate of ill-defined crystals. Between some of the component crystals there was a want of continuity, giving rise to an aperture which looked like an artificial perforation through the stone.

In the reign of King Mindoon Min, a man working in a rice-field on a hill side found a large stone weighing 7 ticals, which he handed to his wife's custody. One day soon afterwards a man named Gna Monk came by selling "gnapi," the native fish condiment; and as the woman had no cash she offered the red stone in exchange for some gnapi. The man, recognising the stone as a Ruby, gave her a rupee's worth of his goods, and carried off his treasure. He then broke the Ruby in two, presenting one half to the king and sending the other for sale to Calcutta. The king discovering the fraud, and finding that he had been cheated out of part of the stone, ordered Gna Monk and all his fellow-villagers to be tortured. Learning that the missing portion was in Calcutta, the king sent thither, and purchased the fragment for an enormous sum. It was then found that the two parts being fitted together formed one stone. The two portions were cut in Burma, one forming a grand stone weighing 98 carats, and named "Gna Monk;" whilst the other weighed 74 carats and became known as "Kallahpyan," signifying that it had returned from India.

A man working on the road to Momeit, during Mindoon Min's rule, found a Ruby weighing in the rough 400 carats, which his wife sold to a man named Moung Lin for 3000 rupees. The purchaser broke the stone into three parts: one was cut in Calcutta, and formed a stone of 70 carats, which was afterwards sold in England; the second

portion weighed, when cut, 45 carats, and was disposed of in Mandalay; whilst the third part went to Calcutta, where it realised 70,000 rupees.

"Gnaga Boh," or The Dragon Lord, is the name given to a Ruby found at Bawbadan, weighing in the rough 44 carats, and when cut 20 carats. This stone, which is said to be the finest of its size ever seen, was given by the finder to King Tharawadis, and is supposed to be in the possession of Theebaw.

Another very fine stone, weighing in the rough 100 carats, was found on Pingtoung Hill soon after Theebaw ascended the throne, and was presented to him by Oo-dwa-gee, at that time Woon of the Ruby Mining district. As several "royal rubies" have at various times been found on this hill, the Company has recently established workings there, which give much promise of success.

The two most important Rubies ever known in Europe, were brought to this country during the year 1875. One was a rich-coloured stone, cushion shaped, weighing 37 carats; the other, a blunt, drop shape, of 47 carats.

It was deemed advisable to have these stones re-cut; and the work was entrusted to the late Mr. J. N. Forster, of London, who re-cut the stone of 37 carats to $32\frac{5}{16}$, and the one of 47 carats to $38\frac{9}{16}$. They were much improved thereby, and competent judges pronounced them the finest stones of their size yet seen, the colour being truly magnificent. The smaller stone of the two was sold abroad for £10,000; the larger one found a purchaser on the Continent for £20,000. The fact of two such fine gems appearing contemporaneously is unparalleled in the history of Precious Stones in Europe. It is questionable, however, if the London market would ever have seen these truly royal gems but for the necessities of the late Burmese

Government. In Burma the sale of these two Rubies caused intense excitement, a military guard being considered necessary to escort the persons conveying the package to the vessel. Two such Rubies are not to be found in any European regalia.

There are, however, some very celebrated and historical Rubies still on record. For example, one of the size of a pigeon's egg in the Russian Regalia was presented to the Empress Catherine by Gustavius III. of Sweden, when on a visit to St. Petersburg, in 1777. Chardin speaks with admiration of a Ruby cut *en cabochon*, of great beauty, and of the size and form of half an egg, having the name of "*Thelk Lephy*" engraved on the end.

In the Exhibition of 1851 there were two engraved Rubies belonging to the Hope Collection, one representing the head of Jupiter-Serapis, the other a full-length figure of Minerva-Poliada. It is probable that most of the historical Rubies of fine colour were originally derived from Burma.

A former King of Burma it is stated, had a perfect Ruby of the size of a pigeon's egg, which he wore as an ear-drop.

It is known that the great historical gem in the Imperial State Crown in the Tower of London, known as "The Black Prince Ruby," is not a Ruby, but a magnificent Spinel. It is cut *en cabochon*, and has a hole drilled through it, now filled up by a plug of similar stone. This gem was presented to the Black Prince by Don Pedro, the Cruel, King of Castile, and was worn in the helmet of King Henry V. at the battle of Agincourt.

In the Ruby mines of Burma, quantities of coarse small rubies are found, too poor for jewelry in this country, but having a certain value, though small, for watch jewelling and

ornamental purposes in the East. The slippers of Chinese and Indian women, for example, are ornamented with Rubies, with convex, non-facetted tops; whilst vases, armour, scabbards and harness, are also graced by the same stone in India and China.

Bags of a coarse kind of Ruby, little better than mixed dust, are laid beneath the foundations of buildings, the idea prevailing that good fortune is thus secured to the structure.

For further information regarding the Ruby Mines of Burma, the reader is referred to Chapters II. and III. of this Section.

SIAM RUBIES.

It has been known for many years that Rubies occur in Siam, but it is only in recent years that they have been systematically worked. Mr. John Crawfurd in his well-known account of the Embassy to the Court of Siam, in 1828, states that Rubies are found in the hills at Chantaboon, and that the working of the stones is a Royal Monopoly, rigidly guarded; but he adds that the Siam Rubies are "much inferior in quality to the Ava Stones."

Mr. H. Maxwell Stuart, a gentleman of high authority on Precious Stones, who went to Siam for Mr. Benson and the author, to obtain the concession of certain mines, enquired with much care into the conditions under which the Rubies and Sapphires occur. He admits that the greater number of the Rubies in Siam are of dark colour, but considers that "many individual stones may be said to rival the best Burma Rubies." In this opinion, the author, after much experience in dealing with Rubies, both from Burma and Siam, fully concurs.

The Ruby mines of Siam are chiefly situated in the Provinces of Chantaboon and Krat, and can be reached by steamer from Bangkok in less than twenty hours. Rubies are also found in the Sapphire mines of Battambong. It appears that the higher parts of the mountains in these districts consists of greyish granite, and that the rest of the country is largely composed of limestone. The precious stones occur in detrital matter, and have been worked in a primitive manner by means of pits, none of which exceed 24 feet in depth. The workings in the Province of Krat have been visited and reported on by Mr. Dimetri, from whose report some of the following details are taken.

The Ruby mines in that Province consist of a large number of workings in two principal groups, about 30 miles from each other, known as the mines of Bo Navong and Bo Channa. The Bo Navong mines, covering an area of about two square miles, include thousands of holes, two to four feet in depth, near the village of Ban Navong. A coarse yellow or brown sand, forming the surface of the country, rests on a bed of clay, and at the junction is the Ruby-bearing sand, forming a stratum from six to ten inches thick. The Bo Navong mines have been worked for the last seventeen years, and the Rubies which they have yielded are of much finer quality, though usually smaller, than those of the other workings.

The group of Bo Channa mines is situated about thirty miles in a north-easterly direction from Bo Navong, and consists of a large number of holes, which have been dug over an area of about one square mile, during the last seven years. The Ruby-bearing sand varies in thickness from six to 24 inches, and some of the pits reach a depth of twenty feet. The natives believe that the Rubies have been washed down by the river from the Kao Sam Nam,

and it is said that in digging near the base of this mountain fine Rubies have been unearthed, but the climate there seems unfortunately to be too unhealthy to permit of operations being systematically and persistently carried out by the English.

At the time of Mr. Dimetris' visit, he found that there were about 1,250 diggers at work at the two sets of mines. A few were Laos and Siamese, but the majority Burmese.

The Chevalier Angello Luzzatti, representing the Anglo-Italian Exploring Association, obtained from the King of Siam, in 1889, a concession of the gem-mines in Chantaboon and Krat; and this concession was subsequently assigned to an English Company styled "The Sapphires and Rubies of Siam, Limited." The Sapphires, which are of more importance in Siam than the Rubies, will be fully described in a subsequent chapter.

CEYLON RUBIES.

From time immemorial the island of Ceylon, or "Taprobane" as it was termed by the classical writers of antiquity, has been famous for precious stones. These are found in the form of rolled crystals and rounded fragments in detrital deposits in the valleys, spread over the lowlands, and in the sands of rivers. Shallow pits are dug by the natives in these deposits, and the gem-stones separated from the associated earth by simple washing. The principal localities for the stones are in the neighbourhood of Ratnapura, or the "City of Gems," and Rakwena. The gem-stones include various kinds of coloured Corundum, but Sapphires are much more common than Rubies. Moreover, the Ceylon Rubies are usually of pale colour, being rose-coloured rather than decidedly red, and of only small value.

The gem-deposits of Ceylon will again be referred to in the chapters on Sapphires, and on Cats' Eyes.

RUBIES FROM OTHER LOCALITIES.

Although Burma, Siam and Ceylon are the only countries which have hitherto yielded Rubies in quantity of any commercial importance, it must be remembered that red or reddish Corundum has been found in many other localities, and it seems likely that the Ruby enjoys a wider geographical distribution than is generally admitted.

At Jagdalak. 32 miles east of Kabul, Rubies were systematically worked by the Amir of Afghanistan. In 1879 the mines were visited by Major G. Stewart; and from specimens supplied by him, it appears, according to Mr. F. R. Mallet, that the Ruby occurs there in a white crystalline micaceous limestone.

Major Moriarty, on his return from Cabul, brought to this country a Ruby, weighing 10½ carats, from the mines of Gandamak, in Afghanistan, which are situated about 30 degs. N. lat., and 70 degs. E. long.

From Thibet the author on one occasion received a large piece of rough Ruby, weighing 2000 carats, forming a flattish slab, measuring on one face 3 inches by 2½ inches. It was, however, opaque and silky, and when cut yielded only Star Stones. Rubies have also been found lately in the Mysore district, and some cut by the author's directions have turned out bright stones, but of small size: the principal part, however, found up to the present has only been Corundum.

Rubies of small size have occasionally been found in some of the tin and gold-bearing gravels of Australia. In

New South Wales they are recorded from the Cudgegong and some of its tributaries, and from Mudgee and a few other localities. In Victoria the Ruby occurs in the drifts of the Beechworth gold-fields, at Pakenham, and elsewhere. A magenta-coloured Corundum, more or less opaque, is known in Victoria under the name of *Barklyite*. On the whole, the red Corundum is far rarer in Australia than the blue Corundum; and the same rule holds good in many other localities, the Ruby being rarer and therefore more prized than the Sapphire.

The so-called "Rubies" from the Macdonnell Ranges in the Northern Territory of South Australia, the discovery of which created great excitement a few years ago, are proved to be nothing but very fine Garnets.

Among the precious stones of the United States of America, coloured Corundums are included. A remarkable deposit of Corundum, associated with Ruby and Sapphire, was described by Col. C. W. Jenks, before the Geological Society of London in 1874. The locality is known as the Lucas Corundum Mine, and is situated in Macon County, North Carolina. The Corundum associated with numerous other minerals, occurs in veins, running through a mass of serpentine, which, rising as a boss through the surrounding granite, is known as Corundum Hill. Some of the crystals yielded by these veins weighed more than 300 lbs. each, and many of them exhibited a curious diversity of colour, so that one part of a crystal might be red, while another portion of the same mass would present blue and green colours. The brightly coloured portions were veritable gems, but mostly too much flawed and otherwise too imperfect to be of value as ornamental stones The discovery was one of considerable mineralogical interest, but of no importance in connection with the production of precious stones.

By far the most important discoveries of coloured Corundums yet made in America are those which have recently attracted attention in Montana. It will be shewn in a subsequent chapter that considerable deposits of Corundum-drift, containing Sapphires of various tints, occur on the Missouri River, especially at Ruby Bar and Eldorado Bar, near Helena. Among these Corundums are occasionally found crystals of various shades of red and violet, which are unquestionably Rubies. Although usually of pale colour, like the Ceylon Rubies, a stone is said to be now and then found of the typical ruby tint. Mr. G. F. Kunz, in describing the Montana Corundums, mentions the occurrence of "bluish red, light red, and red" varieties; and alludes to one specimen weighing about one-eighth of a carat, now in the Amherst College collection, of "a true ruby red." It must be admitted, however, that while the Sapphires of Montana have been found in sufficient abundance to become of commercial importance, the Rubies from this locality have not yet been found in quantity and of good quality. Some authorities conversant with the locality consider, however, that there is reasonable hope of discovering much finer red stones on working the deposits on a large scale, especially at Ruby Bar.

It should be mentioned that travellers, without a critical knowledge of gem-stones, have frequently, and most excusably, mistaken certain Garnets for Rubies.

Before closing this chapter it may be useful to add a few observations on the value and cutting of the Ruby.

The price paid for this stone by the Ancients was very high. According to Benvenuto Cellini, in his time a perfect Ruby of a carat weight cost 800 ecus d'or, whilst a Diamond of like weight cost only 100; the same applies

to-day, for the Ruby ranks in price above all other stones. When a perfect Ruby of five carats is brought into the market a sum will be offered for it ten times the price given for a Diamond of the same weight; but should it reach the weight of 10 carats or more it is almost invaluable.

Even a fine stone may have its value considerably depreciated by injudicious cutting, as is generally done in the East by native lapidaries. The only object gained by having stones cut by the natives previously to sending them here, is, that when native-cut, the flaws and imperfections can be more clearly seen than when in the rough state, and consequently inexpert buyers who are not thoroughly *au fait* with their business can form a more correct estimate of their value. But whatever advantage may be gained in this respect is more than counterbalanced in various ways. In the first place by allowing the native cutters, with their oriental weakness in the matter of *meum* and *tuum*, to manipulate our stones, we open the door to fraud. Secondly, apart from the question of workmanship (which it is well known is inferior), the Indian and European systems are so utterly opposed that the result must be a loss either of weight or beauty. The native cuts for weight only, without the least regard for either brilliancy or shape; whereas on the other hand the English lapidary cuts for brilliancy and colour, even at the sacrifice of weight. In a perfect shaped stone the front, *i.e.*, that part that is above the girdle, should be one third, and the back two thirds of the total thickness of the stone; experience shows that these proportions give the best effect. But in many, or most, of the native-cut Rubies, the front occupies a half, and sometimes more than a half of the entire thickness, with consequent total loss of life

or fire. It is therefore manifest that in re-cutting such a stone to the correct proportions we must expect a greater loss and waste of material than if it had been cut intelligently in the first instance. The moral, therefore is, that no Rubies for the English market should be cut in the East.

Oriental Ruby.

Composition	Alumina.
Specific Gravity	4.
Hardness	9, or slightly under.
System of Crystallization ...	Hexagonal.
Form	Six-sided prisms and pyramids, variously modified, but usually as rolled fragments.

CHAPTER II.

THE RUBY MINES OF BURMA.

ALL attempts to lift the veil of mystery which had enshrouded the famous Ruby Mines of Burma, since the time when they were first brought to the knowledge of Europeans in the fifteenth century, had been utterly fruitless until after our formal annexation of Upper Burma, in the beginning of 1886. Up to that time we were profoundly ignorant of the conditions under which the gem-stones occurred in this inaccessible country. The mines appear to have been acquired by the Burmese from the Shans about 1630; but they were jealously guarded from Europeans, and had been rarely, if ever, visited by anyone possessing a competent knowledge of mineralogy.

Tavernier the famous French jeweller, whose travels during the seventeenth century threw much light upon the occurrrence of Precious Stones in India, has but few remarks, in his published writings, concerning Rubies. He tells us that they are found in "a mountain twelve days or thereabouts from Siren, in a north-east direction, and it is called Capelan." This statement has been repeated, until quite recently, in most works on mineralogy.

The name "Capelan" is probably intended, as suggested by Prinsep, for the well-known locality Kyat-pyin.

Tavernier seems to have been rather unfavourably impressed by what he heard about the mines, and states that the yield did not exceed in annual value 100,000 écus, equivalent to about £22,500. So far from attempting to bring any Oriental Rubies to Europe, he rather took them with him to the East, as he found they were more highly valued there than in the western markets. "I have earned," says the shrewd old traveller, "a sufficiently large profit by bringing Rubies from Europe into Asia."

One of the very few Europeans who are known to have visited the Ruby mines, at least in modern times, appears to have been an English sailor in the service of King Phagyidora, in 1830. He was sent to blast a rock in one of the royal mines at Tapambin; but, he seems, like most strangers who entered the mining district, never to have returned.

The Père Guiseppe d'Amato visited the mines about the year 1833, or a little earlier, and described the native methods of mining. It is known too, that a party of Frenchmen, under an engineer in the King's service, were at the mines in 1881.

A German miner named Bredmeyer was at one time in charge of certain Ruby mines in Burma, but they were merely small workings of little value at Sagyin, near Mandalay, and not mines in the typical Ruby district around Mogok, Kyat-pyin or Kathe.

Soon after the annexation of Upper Burma to the British Empire, the author of this work, under circumstances which will be fully explained in the next chapter, applied to the Indian Government for a concession o mining rights in the newly acquired territory. During the

negotiations, his son, Mr. George Skelton Streeter, Mr. C. Bill, and Mr. Beech, were permitted to accompany the first military expedition to the Ruby mines. In *Murray's Magazine* for May, 1887, an article was published on the subject, which had peculiar interest, since it was written at the mines, and was the first description which had ever appeared from the pen of any European expert in gems, personally acquainted with the stones and the district.

Towards the close of 1887, the India Office commissioned Mr. Barrington Brown, formerly of the Geological Survey of the West Indies, to proceed to Burma and inspect the Ruby mines. The result of this visit was a Report presented to the Secretary of State for India, which partly formed the basis of our knowledge of the geological structure of the country. While at the mines he found the Ruby embedded in a matrix of calc-spar, and recognizing the scientific interest of this occurrence he sent home six specimens, with the request that they should be submitted to Professor J. W. Judd. The specimens were accordingly sent to him by the India Office, and exhibited at a meeting of the Geological Society of London, on June 6, 1888.

At an early stage of the negotiations for a lease of the Ruby Mines, the author had recognized the necessity of having a survey of the district, and had accordingly secured the services of Mr. Robert Gordon, C.E., whose familiarity with the language and customs of the Burmese rendered him peculiarly valuable. On February 27, 1888, he read, before the Royal Geographical Society, a paper descriptive of the district.

The only other paper which need be here referred to is one read by Mr. G. S. Streeter, on February 15, 1889, before the Indian Section of the Society of Arts. Sir Charles Bernard, the first Chief Commissioner of Upper

Burma, occupied the chair. The paper was illustrated by photographs of the mines, and of the inhabitants of the district, Mr. Streeter having taken, during his visits, a large number of views, some of which were published in the *Illustrated London News.*

Such are the principal sources of information at present available to the public, with reference to the famous Ruby mines of Burma. Being desirous of laying before the reader a description of the mines, which should be recent, original and accurate, the author applied to Mr. William S. Lockhart, C.E., who resided at the mines for nearly two years as Engineer-in-Chief to the Burma Ruby Mining Company, and had thus obtained a very intimate knowledge of the district. Mr. Lockhart has obligingly furnished the following description of the district and of the native methods of Ruby mining:—

"The Ruby-mines District of Upper Burma is a large political division, bordering on the left or eastern bank of the Irrawaddy, but the "Stone-tract" proper, in which mining for Rubies is carried on as a recognized industry, extends over an area of about 400 square miles, having as its trade-centre the native town of Mogok with the neighbouring townships of Kyat-pyin and Kathe. The "Stone-tract" is mountainous throughout, but between it and the Irrawaddy there is a stretch of low jungle country, or terai, some 30 miles wide, in the flat portion of which, although not included in the "Stone-tract," some mining on a small scale is carried on by the natives.

"There are also Ruby mines at a place called Sagyin, about 15 miles to the north of Mandalay, where a beautiful white marble is also found and worked. Sagyin forms an outlying spur of the great Shan table-land,

and it is probable that Rubies will be found, more or less, thoughout the whole of the mountainous district, the ranges of which extend from Mogok, southwards, towards Mandalay. Mogok itself lies about 100 miles north of Mandalay and 61 miles by road, though not nearly so much as the crow flies, east of the Irrawaddy. It is situated in the more easterly portion of the "Stone-tract," but it is the chief centre of the mining-industry.

"The country may be described as a dense mass of forest-jungle, rising range after range above the terai, and broken only here and there by alluvial patches at the bottom of the valleys, cultivated for rice. The elevation of Mogok itself is nearly 4000 feet above sea level, and the mountain-peaks about it run up to nearly double this. The climate is very unhealthy, both Europeans and natives suffering considerably from fever and dysentery. The wet season, or "rains," which are very severe, extend from the middle of May to the end of October, the remaining seven months of the year being fine and bright. During December, January and February, the nights are very cold, the thermometer frequently falling to 25° Fahr., and occasionally still lower. March and April are the hot-season.

"The Mines may be divided into 3 classes :— The "*Twin-lone*" or pit, the *Hmyaw-dwin* or hillside working and the *Loo-dwin*, the cavern or cave-mine. The first system is practised in the valley-bottoms in the dry weather. These valleys appear to be beds of former lakes, which, having been gradually filled up by detritus carried down and deposited in them by successive rains, have flowed through a gap in the surrounding hills and disappeared. They are perfectly flat, and below an upper stratum of alluvial soil, at a depth varying from 15 to 20 feet., is found the

bed of "*byōn*" or Ruby-bearing earth. Its thickness is generally 4 or 5 feet, though at times it thins out to only a few inches, and it is almost invariably wet and soft. Below it is generally found a stratum of soft, or as the miners call it "rotten" stone, which is an indication to them that the "*byōn*" has been passed through.

"Having selected a site for his mine, the miner commences operations by driving bamboo-piles down into the soft earth to form the sides of his pit or "twin." The "twins" are either "9 hole" or "4 hole" twins, according to their size and the consequent number of cross-struts required to support the sides. The larger ones are about 9 feet and the smaller ones 6 feet square, the former having 2 and the latter one cross-strut each way. The bamboos having been driven as far as possible, the earth inside is dug out and the piles themselves caulked with grass and leaves to keep out water. The struts are put in every 3 feet, and work is carried on between them, a second set of piles being driven as required inside the first and the work descending in this manner until the byon has been extracted and the "*Akhan*" or substratum unmistakably reached. For hoisting, the Burman uses the old fashioned balance-crane, known all the world over, but constructs it cleverly out of bamboos, and it certainly answers its purpose most admirably. With these cranes water is baled out in stiff close-meshed baskets about 10 ins. square and the byon in little round pliable ones some 6 or 8 inches in diameter. Having extracted the byon in this way, it is piled in a heap and, on a convenient day, is either washed on the spot or carried to a neighbouring stream, according to the supply of water available. The apparatus for washing consists merely of a wooden trough about 5 feet long and large enough for a man to stand in. This is set in the

ground and a stream of water led through it. The lower end is roughly closed with a few large stones to retard the overflow and the byon is then fed in and kept alive by being constantly thrown to the head of the trough by a man with a broad tool like a hoe. In this way the water and light stuff are carried away and the washed sand is taken out from time to time and rewashed in flat fine-meshed baskets something after the manner of panning practised in the diamond-mines, with this difference that the Burman does not work his stones to the centre of his basket, but gets them into the half nearest to him, the large light stuff being rapidly thrown off from the opposite side and the remainder picked through *in* the basket, which is not overturned until done with.

"In some parts and notably in the Kyat-pyin district where the soil is rather stiffer and will stand better, small circular shafts of 2 feet 6 inches to 3 feet diameter, in fact just large enough for a man to work in, are sunk to a depth of 20 to 25 feet to the bed of byon. These shafts are sunk very near together, and the miners drive tunnels from one to another and take out as much of the gem-bearing clay as they dare, but they never resort to either timbering or filling.

"With the advent of the wet-season, work in the twin-lones must cease and that in the "Hmyaw-dwins" or "Hmyaws" commences. The Hmyaws are not mines in the usual sense of the term, but rather cuttings in the hill-sides and vary from the workings of the most insignificant character to vast chasms, though they are all worked on the same principle. A site having been chosen where a bed of byon is believed to exist and where a stream of water can be brought in at the head of the working, a cut is made and the top soil, generally a marly clay, removed by washing

it down with the stream, the stones, of which there are usually a great number, being thrown aside and used as required for building dry retaining walls. The byon in the Hmyaws is generally of a yellowish-brown colour, and very close and stiff so that it will not only stand vertically, but can be undercut and tunnelled into. The thickness of the stratum is often considerable, as much as 15 or 20 feet, and it is practically a bed of very stiff clay, filled with sand and boulders of rock. It contains also lumps of quartz, grains of felspar of several colours, nodules of oxidised iron-pyrites, flakes of mica and graphite, rubies, sapphires, spinels, pieces of tourmaline and other minerals of more or less value. This bed having been found, a space is cleared, and the water supply so arranged by the clever use of bamboos, that it falls in a spray from a considerable height on to the cleared space or washing floor which is occasionally paved, but not usually. On to this floor and under the falling spray, the stiff byon is thrown as it is cut and finds its way down into the tail-water, by which the clay and a good deal of the lighter minerals are carried away and the washed sand deposited, the process being expedited and assisted by men with hoes stationed at intervals along the channel. At convenient spots deeper pools are formed, out of which the sand is lifted in the flat baskets already referred to, washed at the surface of the water, and handed up to a picker who is usually the head-miner or his wife. The rejected sand is thrown in heaps, and it is the privilege of the women and girls of the village to pick these heaps over, and to wash for what they can find in the tail-water after it has left the mine proper.

"The water for these Hmyaws is often brought for miles along the hillsides by ditches, which cost a considerable

sum of money and are very cleverly managed, being in places tunnelled out, while at others the stream is carried across a valley by means of an aqueduct built of bamboos lashed together with strips of cane, the channel being formed of mats which naturally leak a good deal at first, but gradually silt up and answer the purpose admirably.

"The third class of mines, the Loodwins or Loos, are cave workings, and are exceeding interesting, and generally very profitable to the miners. Almost all the mountain-ranges have a base, or skeleton, of calc-spar covered over with the red marly clay or vegetable soil, and in outcrops of this calc-spar, the entrances to the caves are sought and generally found: they are, however, occasionally found by accident during the process of making a hmyaw, an apparent pocket being, on an attempt being made to clear it out, discovered to be the entrance to an extensive loo. In such a case they are frequently filled up solid with clay and byon, and this the miners pick out and carry to a stream near the mouth of the cavern to be washed. The ramifications of these caves are endless, extending in some instances for miles, and whereas at some points they are so contracted that it is only with the utmost difficulty a miner can work his way through inch by inch, lying at full length and drawing a small basket of byon, tied to one toe behind him, at others they open out into immense vaulted chambers, in which the effect of the light falling on the brilliant white walls and glistening over-arching roof is very striking. Huge stalactites hang from the roof or jut in fin-like clusters from the sides; the latter, if large, giving out a sonorous sound, if struck with the hand, and whereas a newly entered cavern often appears at first sight to be empty and paved with bright white stone, the latter proves

to be only a thick crust of stalagmitic matter which has flowed over and perhaps entirely covered a deep bed of byon below.

"In Pingudaung, a very remarkable mountain surmounted by a gilded pagoda, near Kyat-pyin, there was some five-and-twenty years ago, a cavern so vast, and containing so great a depth of byon, that twins and hmyaws are said to have been worked inside, but the roof fell in, burying a number of men and effectually closing all entrances. As may be supposed work in these caverns is attended with considerable danger, and it is only attempted by men thoroughly accustomed to it. Frequently the loo takes the form of a vertical shaft, perhaps a couple of hundred feet deep; sometimes it is a deep underground chasm at the bottom of which subterranean waters may be heard dashing and boiling in the darkness. The air too, is at times so foul as to make it impossible either to work or to keep lights burning, while on the other hand even in the deepest places it is sometimes fresh and clear, often with a current strong enough to blow a light out. The byon is of a far more sandy nature than in either the twins or hmyaws, and though there are generally fewer stones, they are better as to size and quality.

"A Burmese miner's working tools are very simple. He has a rough dress to wear in the mine; his lamp is a little earthenware saucer of oil with a wick burning at one side; for digging he has a spud, shaped like a flat trowel, with either a long or a short haft to suit his work: a "dha," a tool something between a sword and a chopper; a few sprags cut from the nearest tree; bamboos to make a platform when necessary, some creeper stalks to serve as ropes, and he has all he requires. The method of baling water out of the twins has already been described, and for

the loos he uses a really ingenious bucket-pump made out of a big bamboo stem with the joints knocked through. The top is left open, and the rod is worked direct by hand. The bucket is formed out of a piece of raw hide secured to the end of the rod and looped up a little above by a light cord or string, the result being that at the up-stroke the skin is extended and fills the barrel, the pressure of the water above ensuring a joint, and at the down-stroke it closes up like an umbrella and passes easily through the standing water. At the bottom of the pump is a foot-valve similar to the bucket. These pumps are made 8 or 10 feet long, and a long lift is managed by using one above another.

"For hoisting byon out of a deep mine, where a straight lift can be obtained, the balance crane is used, a row of them, say 3 or 4, being planted at the surface side by side. The hoisting rope, which, however, is generally a long, thin bamboo, or several tied end to end, according to the length required, extends in the first to the bottom of the mine, and serves to lift the lowest 15 or 20 feet to a staging, down to which the next crane reaches, and so on, a man being stationed on each platform to shift the baskets as they come up from the wooden hook of one crane to another. The use of modern machinery and of explosives by Burmese miners is prohibited by law.

"There is yet another method of mining, though it is not extensively resorted to. A dam is built across a stream, thereby making a pool, which is dredged by hand, the miner diving to the bottom with a basket, which he fills with his hands or feet and then brings up to be washed and sorted.

"With regard to the origin of the Ruby little is known. It must be clearly understood that the loos are not mines

in the sense of adits or galleries driven for the purpose of winning the gems *found in the rock.* These mines, so called, are natural caverns into which ruby sand and clay have been washed, apparently from above. Both Rubies and Spinels *are*, however, found in the calcspar here and there, but very little of any practical value can be done towards extracting them. From the fact of their being so found, it has been assumed that the calcspar is the matrix of the Ruby, but it is far more probable that the calcspar has formed round the Ruby, though no doubt it is still difficult to see where the latter came from. The appearance of the beds of Ruby-bearing clay, the byon, containing, as they do, all the ingredients of an igneous rock, such as granite, leads rather to the supposition that in the earlier geological history of these regions, such a rock overlay the strata, as they are found to-day, but was entirely removed by subsequent disintegration, the byon beds, after admixture with clay, being composed of their débris. This theory would account for the filling of the caverns and other phenomena, while in other districts, where Sapphires and Rubies are found, it is reported that such a rock is still in existence on the tops of the higher ranges."

Much interesting information with regard to the trade in Rubies, prior to our annexation of Upper Burma, was forwarded from Mandalay, in 1886, by Mr. E. G. Bear. All Rubies of the value of 1,000 Rupees, or more, were claimed by the king; and nothing was given to the finder, in return, except by the king's favour. The chiefs of the mining districts had to pay to the king 2½ lakhs of rupees every year, but part of this sum was derived from the duty levied at the Ruby Hall, or public place of sale, at Mandalay. The duty on the sales was five per cent.

for merchants who were natives of the mining districts, and ten per cent. for others. Moreover, a tax of ten per cent. was levied upon the buyers. It is estimated that the Rubies sent from the mines to the Hall were worth from 50,000 to 10,0000 rupees, per month.

The Ruby Hall, situated at Mâ-lun-zó, in Mandalay, was also a kind of Intelligence Office. It was presided over by a person called Moung-po-moung, who had with him two valuers, called Kyouk-bwé-pyah, and three clerks.

All persons working at the Ruby mines had to obtain licenses, and in order to prevent illicit dealing, no one without a license was permitted to be there. Even ordinary travelling through the mining districts was absolutely forbidden.

Merchants trading in Rubies were bound to obtain licenses, and before proceeding to the mines had to report themselves at the Ruby Hall, stating what money and merchandise they were taking with them, and this information was transmitted to the officials at the mines. At all the principal halting-places on the road to the mines, the merchants and their baggage were subjected to strict examination. If a merchant, having taken with him a small sum, returned with Rubies beyond that value, it was assumed that he had obtained smuggled stones.

Notwithstanding all these precautions, smuggling was carried on to a large extent. Rubies were concealed in the dress and in the hair, and smugglers have been known to bury them before reaching the guard house, and then pass along the road as beggars. As a precaution against such practices, no one was permitted to move up or down the road without orders.

Traders going up to the mines were exposed to considerable extortion, black-mail being levied by dacoit

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leaders, probably with the connivance of some of the officials. On returning from the mines with their Rubies, the traders were officially protected by an escort of about 100 men, who accompanied them as far as Thabeht-kyin. There the escort left, and the merchants had to deliver up their guns. Being thus unprotected they would be at the mercy of dacoits, and hence they were compelled to abandon the land route, and proceed from Thabeht-kyin to Mandalay by the river. Immediately on landing at Mandalay they were conducted to the Ruby Hall.

In the reign of the old king Mindoon, any one found guilty of illicit dealing was publicly flogged at the corners of the streets in Mandalay, and his Rubies confiscated. In King Theebaw's reign the espionage was less strict, and no floggings are reported. During the rule of Mindoon many Royal Rubies were sent in, but none was received in the time of Theebaw; yet it is known that many fine Rubies, of over 1000 rupees' value, were discovered during this time. It is indeed reported that in Theebaw's reign a Ruby was found which was sold for 6,000 rupees, and re-sold for 10,000. Such smuggling was no doubt connected with the system of bribery which had become universal. It is known that during the reign of King Theebaw, Rubies, to the value of not less than two or three lakhs of rupees, were illegally sold every year in Lower Burma!

CHAPTER III.

THE AUTHOR'S CONNECTION WITH THE RUBY MINES OF BURMA.

AS my connection with the Ruby Mines of Upper Burma has been a subject of public curiosity, and not unfrequently of groundless speculation, I have taken the opportunity afforded by the preparation of a new edition of this work to offer a brief sketch, shewing the origin and nature of my relations with these mines.

Most persons interested in precious stones have been fascinated by the glamour of the Oriental Ruby. Many years ago, during King Theebaw's reign, my eldest son, the late Harry Edwin Streeter, who lost his life while pearling with my fleet in the Western Australian waters, expressed a strong desire to visit the Burmese Ruby Mines. Knowing, however, how jealously these mines were guarded from all Europeans, I would not for a moment countenance so hazardous an expedition. But when Upper Burma some years afterwards became part of the British Empire, the case was entirely altered, and I felt that the time had come when the resources of the country—including the mysterious mines which for ages had practically supplied

the world with Rubies—would be thrown open to commercial enterprise.

Whilst in Paris one morning in December 1885, I was taking breakfast in the saloon of the Grand Hotel, when two gentlemen sitting at the same table happened to be talking about the Ruby mines of Burma. They referred to a lease, which was to have been granted by King Theebaw to certain Frenchmen, conceding the right of working the mines, but which, in consequence of the British occupation of the country, had never been signed. Naturally feeling deep interest in such a subject, I joined in the conversation, with the result that I was afterwards introduced to the parties in treaty for the concession. It appeared that Messrs. Bouveillein & Co. had petitioned the king to grant them the sole right of mining for Rubies, in consideration of an annual payment of three lakhs of rupees. They further agreed to pay four years' rent in advance, and to make a present of one lakh to the king. The Burmese Ambassadors in Paris had granted a provisional concession, and this I ultimately obtained, together with all the documents relating thereto, but being of no value they were returned to Paris.

On my return to England, I immediately placed myself in communication with the India Office, with the view of obtaining a concession of the Ruby mines in Upper Burma. On December 24, I was officially informed by Lord Harris that it was for the Government of India to decide upon my application; and it was suggested, in the same letter, that I should communicate directly with the Secretary of the Foreign Department at Calcutta. After some further correspondence, it was agreed that I should send an accredited agent to the Indian Government with the view of personally effecting the negociations.

Associating myself with three friends we formed a syndicate to carry out our enterprise, and engaged the services of Captain Aubrey Patton (now Major Patton-Bethune) as our representative. In January 1886 Captain Patton started for India on our behalf, furnished with a letter of introduction from Lord Harris to Lord Dufferin, who was then Viceroy. On arriving at Rangoon, our agent found that Messrs. Gillanders, Arbuthnot & Co., of Calcutta and Rangoon, in conjunction with an eminent jewel broker of London, had already made an offer to the Government for a lease of the Ruby mines at the annual rent of two lakhs of rupees. This offer the Government was disposed to accept; but our representative, who had full discretionary powers, made an offer of three lakhs, whereupon the Viceroy telegraphed home for enquiry as to the *bonâ fides* of my syndicate. The India Office sent in reply a favourable telegram; but notwithstanding this assurance, the Indian Government, after some further negotiations, decided to invite public tenders.

Having reason to believe that several competitors might appear, we deemed it expedient to increase our offer, and finally our tender was made for four lakhs of rupees. On April 15, 1886, a telegram from the Foreign Secretary in India informed our representative that his tender, on our behalf, had been conditionally accepted by the Governor in Council.

Whilst the negotiations respecting the terms of the concession were proceeding, it was suggested that, as soon as a convenient opportunity offered, our syndicate should send an engineer to report upon the mines. For this purpose we selected Mr. Robert Gordon, C.E., who had held important official appointments in Rangoon and elsewhere, and was familiar with the Burmese language.

Considerable delay arose before he could proceed on his mission; but ultimately he visited and surveyed the mining district.

It had been decided, in July, 1886, to despatch a military expedition to the mines, and the Government of India wrote to our agent, suggesting that a representative of the syndicate should accompany the force. Accordingly, my son, Mr. George Skelton Streeter, with Mr. Charles Bill, J.P., and Mr. Reginald Beech, the three members of my syndicate, started at once. They arrived in India in August; and, after seeing Captain Patton at Simla, proceeded to Rangoon, and thence to Mandalay, where they were kindly received by Sir Charles Bernard, the Chief Commissioner, with whom they had a long conference on the important subject of native rights at the Ruby mines.

Delayed by heavy rains and by sickness among the troops, the Ruby mines column did not make a start until November. In due course they reached Kyan-nyat, a township on the left bank of the Irrawaddy, which it was intended to use as a base. Here news reached the party that organised resistance was being prepared by the hill-tribes in the mining districts. The dacoits were also giving much trouble. As the expedition advanced and approached the mountain pass which leads to Mogok, the principal seat of the Ruby mining, determined resistance was encountered and skirmishes ensued. One of the Ghoorkhas, who brought to my son the head of a dacoit, seemed much surprised that the sight of this trophy, the relic of an enemy just slain, should afford him no pleasure!

By this time the troops had reached an altitude of some 6,000 feet above sea level. The thermometer during

the night registered 6 degrees below freezing point, and as no provision had been made for so low a temperature, great inconvenience and even hardship was felt. The gorge in the mountains had been carefully stockaded by the enemy, and the curiously shaped rocks were skilfully turned into positions of defence; but as the troops approached, these posts were abandoned one after another, and progress was effected without much difficulty.

Mogok was ultimately reached on December 27th; and, to the surprise of the expedition, was found to be deserted. The panthays were sent out to call in the people from their hiding places in the jungle, and gradually the villagers returned, but a long time elapsed before any of the headmen appeared.

While the expedition was at Mogok, great difficulties were experienced and much privation endured; but at the same time a good deal of information, previously unknown, respecting the mines and the system of working them, was gradually collected. It was discovered that the lessees under King Theebaw were not licensed to work the mines themselves, but paid 2½ lakhs of rupees, per annum, for the privilege of collecting taxes and dues. The lessees financed the affairs of the poor miners, lending them money for which they extorted exorbitant interest, and otherwise using their great power oppressively. In February, 1887, Mr. F. Atlay, son of the Bishop of Hereford, arrived at the mines, with an interpreter, to act as our representative after my son had left the district, and he subsequently became manager of the mines for us. He still holds a position there for the present Company.

At the request of Mr. Carter, the Deputy Commissioner, my son acted as valuer for the Government, of

all stones brought in by the natives—a task of great delicacy, difficulty and, at this early period of our occupancy, even of danger. At a later period he was present with Mr. Crostwaithe, the Chief Commissioner, at an interview with the principal headmen of the district, when the regulations for the management of the mines were discussed, and the rights of the native workers defined and protected. In April, 1887, he signed a provisional agreement with the Chief Commissioner for a lease of the mines for five-and-a-half years; and, pending the confirmation of the agreement by the Secretary of State for India, he obtained the Chief Commissioner's sanction to hold an ordinary mining licence. He likewise obtained the monopoly of purchasing stones in the Ruby tract on payment of an *ad valorem* duty of 30 per cent. to the Indian Government. Shortly afterwards he returned to Mandalay, *en route* to England, leaving Mr. Atlay at Mogok to carry on mining work at the mines and to purchase Rubies on behalf of our syndicate. Mr. Atlay, thus left to himself, soon found that he was exposed to much treachery and that he was powerless to prevent smuggling by the miners.

Meanwhile difficulties had arisen at home as to granting the concession. Notwithstanding the large sum of money, which we had expended since we had been the accepted concessionaires of the Government of India, the Secretary of State in Council declined to ratify the provisional agreement, until he had obtained definite information as to the value of the mines and as to the protection of native rights. With the view of ascertaining the value, it was decided to send from England an experienced Mining Geologist to report upon the mines and their probable yield. Accordingly Mr. C. Barrington Brown was commissioned

to proceed to Burma, and he reached the Ruby mines on January 10, 1888.

Nearly at the same time, my son arrived at the mines, our Syndicate having considered it desirable in consequence of unexpected difficulties, that he should again visit the district. When the time arrived for renewal of the licences, the Government of India, under orders from the Home Government, refused to renew ours, although the native licences were duly renewed. Mr. Atlay being thus restrained from mining, was compelled to restrict his operations to the purchase of stones from the miners under the conditions previously explained.

Those who were acquainted with the working of the machinery behind the scenes were not altogether without an explanation of the remarkable change of attitude towards our Syndicate. An enterprise of so romantic a nature as the exploration of the famous Ruby Mines of Burma could not fail to attract much public attention; and both in Parliament and in the Press, at home and in India, frequent reference was made to our operations. After Mr. Durant, the Foreign Secretary of the India Government, had informed Captain Patton, on April 15, 1887, that the Governor in Council had conditionally accepted our tender, we were led to conclude, not unnaturally, that the negotiations were practically settled in our favour; and most people regarded us as undoubtedly the accepted concessionaires. But it was not long before the jealousy of disappointed competitors began to find public expression. Certain members of the House of Commons were prompted by them to ask questions framed in such a way as to prejudice our interests. Nor were political influences wanting in the opposition to our concession. Great injustice was also done to me, and still more to the Indian officials,

by the unfounded criticisms and unfair suggestions of a portion of the London press. From time to time telegrams from Rangoon, extremely prejudicial to our interests, sent over by the *Times* correspondent, appeared in that paper; but it was not without significance that the Rangoon correspondent of *The Times* was the legal adviser of Messrs. Gillanders, Arbuthnot and Company, one of our rivals for the concession. If any undue influence was at work during the negotiations, as insinuated by the Press, *it was most assuredly not on our side*, and the idea, as suggested in certain papers, of our bribing some of the Indian officials was *absolutely unfounded.* I can say that in not one instance did I give, or offer, a bribe during the whole time the Government of India and Parliament at home, extending nearly over three years, were slowly coming to a decision.

Considerable trouble was occasioned during the negotiations by the action of a certain Mr. Moritz Unger, who ultimately represented himself as acting for Messrs. Rothschild, and whose supposed grievances as an applicant for the concession were laid before the House of Commons. He made no application until March 1886, and then "presented himself to the Chief Commissioner of Burma as the agent of a Syndicate in Paris, and as the mouthpiece of certain unnamed European capitalists." These words are quoted from a telegram from the Viceroy to Lord Cross, dated June 5, 1887, and this same telegram, referring to the conditional agreement with our Syndicate, concluded with the noteworthy expression: "We see no just grounds for cancelling this agreement." But, strangely enough, Lord Cross, the Secretary of State, thereupon telegraphed to the Viceroy: "Make no arrangement with anyone without sanction from home." It is difficult to reconcile such instructions from Lord Cross with the

statement in Lord Harris's letter to me that the concession was "a matter for the Government of India to decide!"

It was naturally with much surprise and disappointment that we found the India Office suddenly adopting a new policy, and practically cancelling the action of the Viceroy, Lord Dufferin. The fact seemed to be ignored that we had obtained the conditional concession simply because we had made the highest tender. The suspicion of a "job" having been perpetrated was utterly groundless. After our tender had been accepted in India, we had incurred extremely heavy financial responsibilities, whilst our representatives, who had gone as pioneers to the mines, went under conditions of great difficulty and danger, to the injury of their health, and at the imminent peril of their lives. Yet all our claims, legal and moral, were suddenly ignored by the Government at home!

It is pleasing to record that on the official publication of the correspondence in the "Blue Books," public opinion veered round in our favour, and *The Times* of August 17th, 1887, and most other papers, published articles upon the unfair treatment which we had received from the English Government, whilst speeches favourable to our interests were delivered in the House of Commons.

In due course Mr. Barrington Brown's Report was received by the Secretary of State, and ultimately, the affair of the lease was thrown into the open market. Tenders were again invited, and on November 21, 1888, we sent in a fresh offer, in which we renewed, with some modifications, our former terms. On November 27, the India Office advised me that my offer was accepted, and that the Burma Ruby Mines would be leased to my Syndicate for seven years, with option of renewal, at an

annual rental of four lakhs of rupees, *plus* one-sixth of its nett value.

The lease from the Government was signed on February 22, 1889; and shortly afterwards "The Burma Ruby Mines, Limited,"—a Company to which the lease had, by permission, been assigned,—was brought out by Messrs. N. M. Rothschild and Sons. For an account of the issue, the reader may be referred to *The Times*, of 27 February, 1889.

With the formation of this Company, the management of affairs passed out of my hands, and my direct connexion with the Ruby Mines of Burma ceased. I am consequently in no way responsible for the disappointing results which have hitherto attended the Company's operations. At the same time I do not hesitate to reiterate my belief that the Burma Ruby Mines, if skilfully directed and well managed, will yet be a highly remunerative enterprise. But in order to secure success it is of first importance that the management should be in the hands of those who have had experience in the special manipulation and cutting of gem-stones. Not only should the Company prosecute its own mining operations with vigour, but it should have at the mines and also in Mandalay, experts empowered to purchase rough stones from the native miners and dealers; and I feel assured that if these were purchased with discretion, and judiciously cut in this country, a new and important source of profit would be opened up, sufficient to place the Company at once on a firm dividend-paying basis.

CHAPTER IV.

THE SAPPHIRE

BEAUTIFUL as this gem unquestionably is, it probably derives no little enhancement of interest from the exalted character of the comparison with which it is associated in the Sacred Volume. The Prophet of the great captivity compares "the appearance of the likeness of a throne" in the firmament above the cherubim to a "Sapphire Stone;" and generally it may be affirmed that around no Precious Stone can be grouped more imposing allegories and properties that have been associated with the Sapphire.

Up to quite modern times the Sapphire was regarded as a charm or a medicine, and very extraordinary powers were attributed to it. It was dedicated by the Greeks to Apollo, because, when consulting his oracle, they thought that the possession of this gem, from its heavenly nature, would secure them an early and favourable answer.

And yet it may be fairly doubted whether the Sapphire of the modern mineralogist has any relation, save the possession of a blue colour, with the *Sapphirus* of ancient writers. It is certain that Theophrastus and Pliny—our great authorities on ancient mineralogy—included the Lapis-Lazuli under the term Sapphirus, since they clearly

refer to the so-called spots of gold with which the stone is bespangled—a description which in no way accords with the character of our modern Sapphire.

The late Rev. C. W. King argued, with great erudition and much show of reason, in favour of our Sapphire having been identical with the ancient *Hyacinthus*. Witness, for example, the following description of the stone by Solinus :—" Amongst those things of which we have treated is found also the Hyacinthus, of a shining blue colour, a stone of price, if it be found without blemish, for it is extremely subject to defects. For generally it is either diluted with violet or clouded with dark shades, or else melts away into a watery hue with too much whiteness. The best colour of the stone is an equable one, neither dulled by too deep a dye, nor too clear with excessive transparency, but which draws a sweetly-coloured tint from the double mixture of brightness and violet. This is the gem that feels the influence of the air, and sympathises with the heavens, and does not shine equally if the sky be cloudy or bright. Besides, when put into the mouth it is colder than other stones. For engraving upon, indeed, it is by no means adapted, inasmuch as it defies all grinding; it is not, however, entirely invincible, since it is engraved upon, and cut into shape by means of the Diamond."

In this passage, Solinus refers to several characteristics of our Sapphire, especially its blue colour and its extreme hardness. The Sapphire is, in fact, only a variety of Corundum, or crystallized alumina; and much, therefore, that was said under the head of Ruby, will apply to the Sapphire.

The characteristic colour of the Sapphire is a clear blue, very like that of the blossom of the little "corn flower," and the more velvety its appearance, the greater

its value. Some Sapphires retain their colour by gas light, while others become dark, and some assume a reddish or purple colour, and occasionally have the hue of the Amethyst; the latter being rare are very valuable.

While the typical colour of Sapphire is blue, it should be explained that the term Sapphire is extended by mineralogists and jewellers to Corundums of other colours. Thus, we may have *green* Sapphires, a variety which has generally been regarded as amongst the rarest of precious stones; other Sapphires may present various shades of *yellow* and *grey*, whilst others again may be entirely destitute of colour; these pure *white* Sapphires being sometimes mistaken, when skilfully cut, for diamonds. In fact, transparent Corundums fit for jewelry may be ranged in two groups; those of red or reddish colours being called Ruby, and those of any other tint passing under the designation of *Sapphire*.

Although Sapphires enjoy a fairly wide geographical distribution, those which present the standard colour, or the true corn-flower blue, are by no means common. The principal Sapphire-yielding localities now worked are in Siam, Burma, Cashmere and Ceylon. Each of these localities will be separately described in the course of this chapter. The Sapphires of Siam are the finest at present in the market; those of Burma are too dark or blackish; the recent discoveries in Cashmere have yielded some very fine stones, but others are only greyish-blue; while those of Ceylon are usually too pale in colour to be of great value. Large deposits of Sapphire are known to occur in Montana, but the stones are mostly of green and other fancy tints, and not deep blue. The Sapphires of Australia, and the few other localities known to yield this gem, are not at present of any commercial significance. It will thus

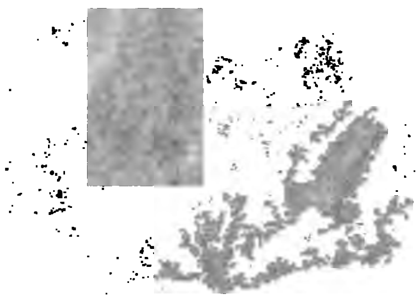
be seen that the localities for really fine Sapphires are extremely limited.

Amongst the celebrated known Sapphires is one in the collection of minerals in the Jardin des Plantes, in Paris, weighing $133\frac{1}{16}$ carats, and without spot or fault. This stone is said to have been originally found in Bengal by a poor man ; it subsequently came into the possession of the House of Raspoli, in Rome, who, in their turn, left it to a German prince, who sold it to the French jewel merchant, Perret, for £6,800.

The most important Sapphires known in Europe are two magnificent stones which were exhibited in the London Exhibition of 1862, and in the Paris Exhibition of 1867. The larger is a stone of a somewhat oval form, of a dark, slightly inky, colour, free from defects. It weighs about 252 carats, and was cut from the rough by Mr. Loop in 1840. The other, although a smaller, is a richer coloured stone. It was brought to this country from India (Indian cut) in the year 1856. In its original form it was a badly-shaped stone, weighing 225 carats, with a large yellow flaw at the back, which marred the stone by casting a green reflection into it. It was placed in the hands of the late Mr. J. N. Forster, successor to Loop, who re-cut it, removed the defects and made it a splendid gem of 165 carats. This, which is by far the finest Sapphire of the size in Europe, was sold in Paris, and is estimated to be worth from £7,000 to £8,000.

In the Hope collection there was a large Sapphire of a rich colour, which retained its beauty as well by candle as by daylight. Another, in the Orleans Collection, was called in Madame de Genli's tale " Le Saphir Merveilleux."

The value of these stones is very much determined by special circumstances and, like the Diamond, the colour,



SAPPHIRE in the Matrix.

purity, and size must be taken into consideration when fixing the sum to be paid.

A perfect Oriental Sapphire weighing between two and three carats is nearly as costly as a good Diamond of like weight. The imperfections which appear at times in the Sapphire, and which lessen its value, are clouds, milky half-opaque spots, white glassy stripes, rents, knots, a congregating of colours at one spot, and silky-looking flakes on the table of the stone. Whenever a Sapphire obtains a purple tint it is an unfailing indication of the presence of the silky defect somewhere in the stone. If a greenish tint be observable, then a "milky flaw" will probably be detected on careful examination.

Varieties of the "Doublet," and "Triplet," are made of the Sapphire as well of the Ruby and other gems; these consist of thin layers of true stone facing crystal, so as to appear but one stone. They may be distinguished from the genuine stone, partly by their colour, but more especially by a careful examination of the girdle, when should the Sapphire, or other gem, have been joined to an inferior stone, the attempted deception will be easily detected.

Notwithstanding the extreme hardness of the Sapphire, there are some beautifully engraved specimens of this gem still in existence. In the Cabinet of Strozzi, in Rome, is a Sapphire, a masterpiece of art, with the profile of Hercules, engraven on it, by Cneïus. A very remarkable and famous Sapphire, belonging to the Marchese Rinuccini, weighing fifty-three carats, has a representation of a hunting scene engraven upon it, with the inscription "Constantius Aug." Among a number of old family jewels there was found by the author, a few years ago, a Sapphire beautifully engraved with the crest and arms of Cardinal Wolsey.

SIAM SAPPHIRES.

The finest Sapphires are obtained at the present day from certain mines in the Kingdom of Siam. They occur principally in the Province of Battambong where they have been systematically worked only within the last few years; and they are also found, associated with Rubies, in Chantaboon and Krat. So extensive is the trade in Siamese Sapphires that one of the principal gem-brokers in London certified that he sold wholesale in the course of the year 1889 nearly £70,000 worth of these stones. It is estimated that the Bo Pie Rin mines, in Battambong, alone supply about five-eighths of the Sapphires of the world. The stones yielded by these mines present an unrivalled velvety blue colour, and it fortunately happens that the Sapphires of over one carat in weight are better in colour and in general quality than smaller stones. Although the mines have only been regularly worked for about twenty years, the occurrence of Sapphires there was probably known to the natives long previously, and the stones may have been imported through Burma.

The mines consist of rude excavations on the sides of the mountain and in the Phelin Valley. These excavations usually take the form of pits about 4 feet square, varying in depth from 5 to 12 feet. The actual stratum which contains the Sapphires is a clay, with a very small admixture of gravel, generally occurring at about two feet below the surface. The miners work in gangs of two or three in each pit, and raise the Sapphire-earth in baskets, by means of ropes made with creepers. The clay is washed, and the gems are picked out of the residuum by hand. The miners are chiefly Shans and Burmese, but there are a few Siamese, Laos and Cambodians. A wild people called Kamin also work, and have the curious habit of not

allowing the buyer to see the Sapphires before purchasing; the stones being put into a short joint of a small bamboo, and the intending purchaser being compelled to judge of their weight by the rattle they make when shaken.

The great gem-bearing country of Siam, so far as at present known, covers approximately an area of about one hundred square miles, with the sea-port of Chantaboon as a trade centre. It appears that the gem mines in the province of Chantaboon have been worked much longer than those of Battambong.

The Sapphire mines of Siam have been visited on more than one occasion by Englishmen, who have formed a very high opinion of their value; whilst the Ruby mines of Krat have been examined by M. Demetri, who reported on them to the Chevalier Angelo Luzzatti. The mines of Bo Navong and Bo Channa, which have been described in the Chapter on Siam Rubies, also yield Sapphires.

Systematic mining for Sapphires and other gem-stones has been commenced by the Company which was formed in 1890 under the name of "The Sapphires and Rubies of Siam, Limited," and at the time these pages are passing through the press, the first consignment of 30,000 carats from these mines has been sent to London.

BURMA SAPPHIRES.

It is well known that Sapphires are found, associated with Rubies, in Upper Burma, but they are not very common and are usually of a blackish colour. When Mr. Atlay worked the Ruby mines for the author, before the formation of the Company, he frequently obtained Sapphires in association with the Rubies. Mr. G. S. Streeter

on one occasion visited a famous old mine which had yielded Sapphires, but found it in a very dangerous condition, the surrounding rock at the top being so rotten that he had to be secured by means of ropes.

Although the Burmese Sapphires are not generally of very fine quality, they occur of larger size than the associated Rubies, and occasionally present exceptional dimensions. About ten years ago, a Sapphire of 820 carats was found at Pyoung Goung (Bernardmyo), and was exhibited for some time as a curiosity at Kyat-Pyin. It was purchased by Gna Myo, then So Thugyi of Kyat-Pyin, for 4,000 rupees, and was accepted by King Theebaw, in lieu of a payment of monopoly rent of 10,000 rupees.

A Sapphire weighing nearly 400 carats, found at Bawbadan, was purchased by Oo-dwa-gyi, the Woon of the Ruby tract, for 6,000 rupees, and after passing into Theebaw's possession, was sold to Moung Ba, a dealer in Mandalay, for 20,000 rupees. It was then cut similar to a brilliant, and reduced in weight to 120 carats, and was ultimately disposed of in Calcutta.

The finest Sapphire ever seen in Burma was dug up in King Mindoon Min's reign, at Wetloo village, between Kyat-pyin and Khabine. In the rough it weighed 253 carats, and, when Indian cut, 161 carats. It was purchased for the king for 7,000 rupees, and passed ultimately into the hands of Theebaw.

CASHMERE SAPPHIRES.

A remarkable discovery of Sapphires was made about ten years ago, in the Chinab valley of the Himalayas of Cashmere (Kashmir). According to the Rev.

A. W. Heyde, a Moravian missionary, who was for many years resident in Lahul, they were first discovered by a *shikari* about the year 1880. It appears that a landslip had laid bare the rock, and exposed the Sapphires. The precise locality was long kept secret, but from information received by the author, there is no doubt that it is situated between the two villages of Soonjam and Machel, in the neighbourhood of Padar. The exact spot seems to be difficult of access, and to be situated at a great elevation near the limit of perpetual snow. The surrounding rocks consist of gneiss, with intercalated crystalline limestones dipping to the east at an angle of about 40 degrees. The gneiss contains garnets, and is intersected by veins of granite in which the Corundum occurs, associated with much Tourmaline. The Sapphires were found loose among the granitic detritus, in the side of a valley, high up on the mountains.

By far the greater number of the Sapphires were fragments of crystals more or less rolled. A description of the crystals was published, soon after the discovery, by Mr. F. R. Mallet, in the Records of the Geological Survey of India. He points out that the crystals were mostly double hexagonal pyramids, often irregular in shape, much flattened, and deeply furrowed with horizontal striations. The larger number were milky, and of pale bluish-grey colour, whilst many were rendered imperfect by "silkiness." The rough Sapphires were in many cases penetrated by dark brown and green Tourmaline. Specimens in the author's collection of rough Precious Stones exhibit these characters. The Sapphire mines have been visited by Mr. T. D. La Touche, of the Geological Survey of India, who has described them in the official "Records," and from his paper the plate of the Mines illustrating this chapter has been taken.

Some of the Cashmere Sapphires are of very fine colours, but many are depreciated in value by a slight opacity, and appear streaky in a strong light. The original supply soon became exhausted, but it is believed that another landslip has recently occurred and exposed fresh deposits.

The discovery of Sapphires in Cashmere is said to have taken place in this wise. Near the spot where the stones are found lived a "Bhôt Lamba," or monk, who first observed a pale blue vein in the rock. He broke off pieces and exchanged them with traders for sugar and tobacco, carefully concealing from whence he obtained his treasures. Subsequently he disposed of a quantity to some Lahul men, who took them to Simla. One piece said to have been about a foot long and three or four inches in circumference, he was persuaded to give to one of his brotherhood, in order to have a "Shib" or idol made of it. A lapidary who was to make it into an idol, finding it extremely hard, came to the conclusion it must be of value; and showed it to an official, who decided to send it to the Maharajah of Cashmere, at Jummoo. On enquiry being made, a messenger was despatched to bring the Lamba who found the stone, and he was forced to disclose the locality where he obtained it. The Maharajah immediately sent a responsible official and a strong guard to protect the place, until the actual value of the discovery should be known.

Sapphires are also found by the Lacha Pass. A native loaded 100 goats with them, and came to Simla through Kulu, a journey of about 10 days. Arriving at Simla, he tried to dispose of them, but their value not being recognised, he could not even obtain a rupee a tolla

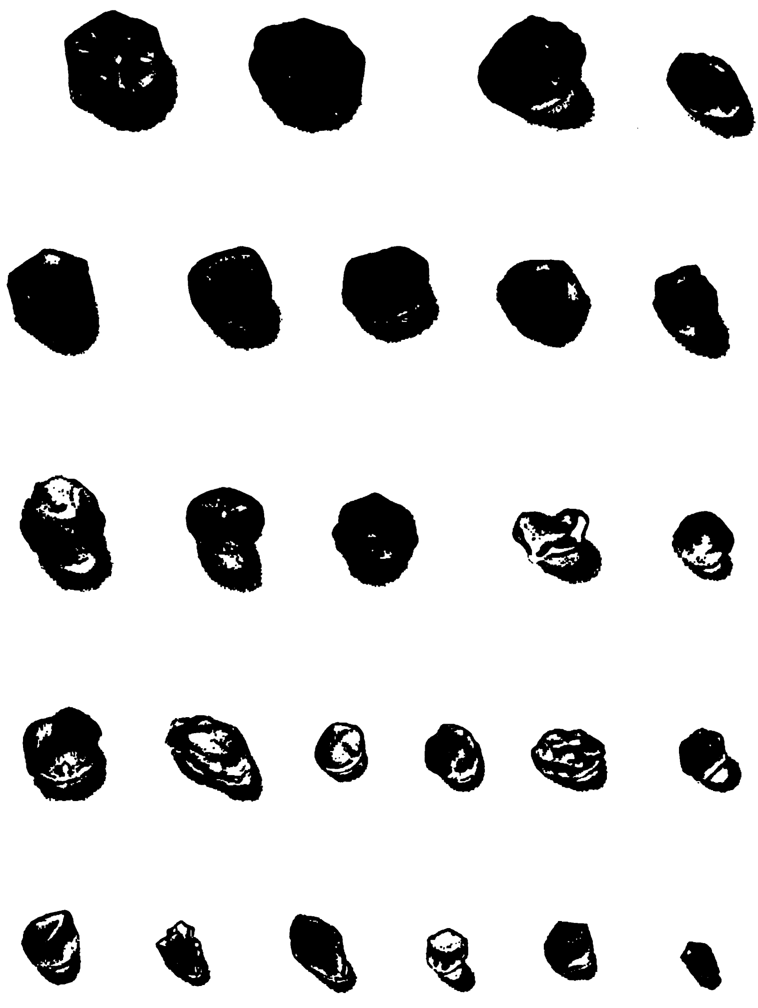
for them, which he would gladly have taken, being in a state of semi-starvation. He then proceeded to Delhi, where the jewellers, knowing them to be Sapphires, gave him their value, had them cut and consigned them to London.

CEYLON SAPPHIRES.

In Ceylon the Sapphires are usually found with other gems either in the old river beds or in a bed of gravel, which occurs at a depth of from 6 to 20 feet beneath the surface. The villagers have sunk numerous pits in this gravel, and work in gangs of six or eight. After stripping off the surface soil, they probe the ground with an iron rod, about six feet long, in order to ascertain the position of the gem-gravel. When found, the gravel is dug into, and tunnelled round the bottom as far as the firmness of the bed permits. The gravel dug out is washed in wicker baskets, and the stones picked out by hand.

Whilst the greater part of the Corundum found in these gravels is too coarse for use as gem-stones, there are found in the old river gravels considerable quantities of true Sapphires, more or less transparent, but often of pale colour. Some of the Sapphires are white and some yellow, while others are parti-coloured, the blue being confined in many cases to one part only of the crystal. With the Sapphires are found rolled crystals of Zircon, Tourmaline, Chrysoberyl, Spinel, and Quartz.

According to the *Ceylon Observer*, of May 4, 1889, there had been recently found "a monster Blue Sapphire, the shape of a piece of jaggery, weighing down in the scales 17 rupees."



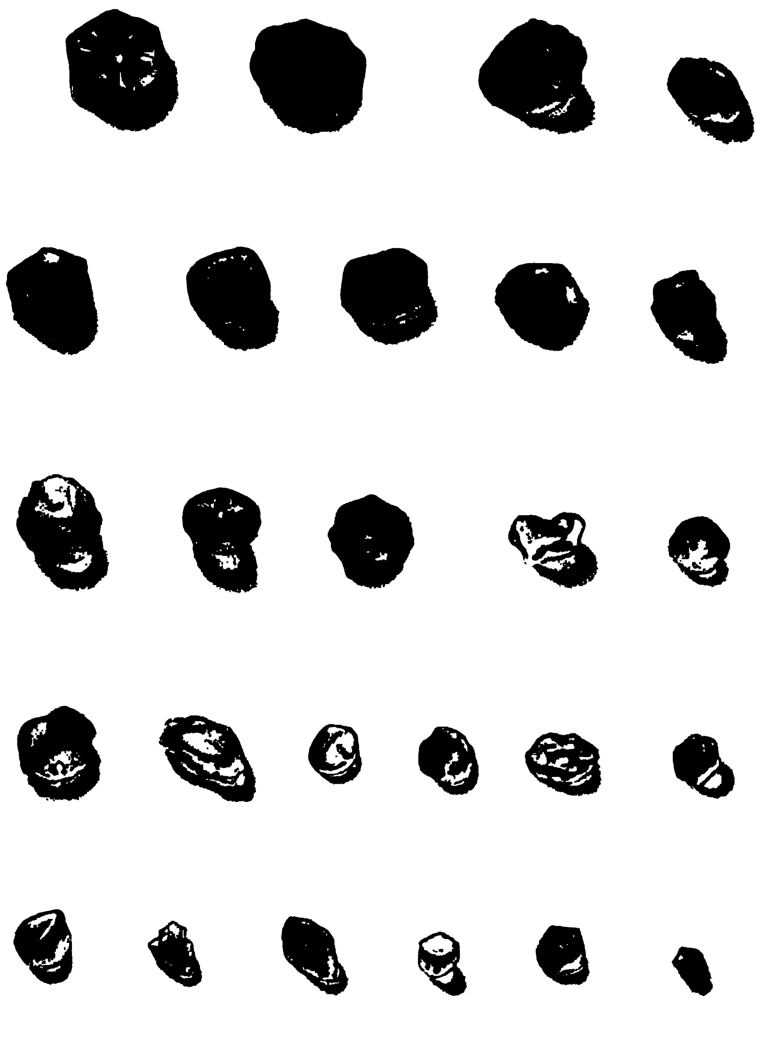
ROUGH MONTANA SAPPHIRES AND RUBIES.

MONTANA SAPPHIRES,

Written after the Author's visit to the locality in December, 1891.

Although it is only recently that the value and importance of the Sapphire mines of Montana have been recognized, the existence of the gem-stones at this locality has long been known. In working the gold-bearing drifts of the Missouri river, near Helena, Montana, there were found numbers of curiously-shaped stones which attracted the attention of the gold-mining pioneers; but after casual enquiry it was stated by jewellers that they were nothing more than quartz, and consequently of no value. The restless gold-seeker, did not therefore trouble to collect them, and after the failure of the supply of water, he moved on to what he thought more promising fields, and the "curious crystals" were forgotten. A few of them, however, were carried away by the wandering miners, and ultimately found their way to Messrs. Tiffany, jewellers, of New York, where they were recognized as Sapphires and Rubies, and the fine gem-stones, after cutting, found a ready sale at good prices.

It is stated by Mr. George B. Foote, one of the pioneers of Helena, that the first discovery of these gems was made at Eldorado Bar, in December, 1865. The earliest scientific reference to the stones was from the pen of the late Dr. J. Lawrence Smith, the eminent mineralogist, who in a paper contributed to the *American Journal of Science* for September, 1873, called attention to the "existence of the Ruby and Sapphire in North Carolina and Montana Territory." Some years later Mr. George F. Kunz, the gem expert of Messrs.



ROUGH MONTANA SAPPHIRES AND RUBIES.

Tiffany & Co., described the Montana gem-stones in a Report, published in the official volume, entitled "Mineral Resources, of the United States," 1883. Subsequently Mr. Kunz contributed to "Harper's Magazine" (December, 1887) a paper on "Precious Stones in the United States" in which he says: "The finest Sapphires for gems are collected by the miners, from the sluice-boxes of the placer mines, near Helena, Montana. The gems are usually light-green, blue, red and all intermediate shades. . . . . A few small gems, less than one carat in weight, have come from the same place. They were truly ruby red and sapphire blue. Of the latter colour perfect gems have been found here up to nine carats in weight."

Following this statement, certain American capitalists commenced the work of systematically prospecting for the gems over a large area, along the Missouri river, and determining the extent of the gem-bearing lands. The limits being defined, a consolidation was secured of all the then known gem-mines in the State of Montana, and ultimately a Company was formed in London, under the title of "The Sapphire aud Ruby Company of Montana, Limited;" the object of this Company being to open and work the mines on a large scale, and to work for alluvial gold.

The attention of the author was first directed to these gems in the early part of 1890, when a quantity of prospector's samples from "Eldorado Bar." and "Ruby Bar," reached London for purposes of valuation and cutting. The crystalline system, specific gravity and hardness sufficiently identified them as true Sapphires, that is, crystallized alumina. They were also submitted to Mr. F. W. Rudler, the Curator of the Museum of Practical Geology, in Jermyn-street, who has had great experience in the determination of minerals ahd discriminations of Precious

Stones. After a careful examination of their physical characteristics, he pronounced them to be variously-coloured Sapphires. Some of the stones were subsequently submitted to Professor A. H. Church, F.R.S., one of our highest scientific authorities on precious stones, and he at once certified that they were true Sapphires. Professor Sylvanus P. Thompson, F.R.S., also studied their optical and other physical characters, and as a final corroboration, he caused a chemical analysis to be made in his laboratory, which proved them to be pure alumina, with a trace of iron too small to be expressed in figures. The stones have also been examined by Professor Crookes, F.R.S., and several other eminent men of science, and experts in gems. The scientific evidence of the mineralogical characters of the Montana Sapphires is therefore placed beyond dispute.

The stones usually present the form of hexagonal tabular crystals, more or less rolled, many being fractured and splintered, and differing somewhat from the ordinary Sapphire crystals of other well-known localities, where the prevailing form is that of the double hexagonal pyramid. The Montana stones present almost all colours and shades, including greens, violets, yellows, blues and pinks. The variety of delicate tints is extraordinary ; and, when well cut, the brilliancy of the stones is remarkable, being inferior only to that of diamonds. Many of the stones have triangular markings, somewhat similar to those on the diamonds of South Africa. It is notable that some of the Sapphires of green and light blue shades become purple or red by artificial light. The lapidaries who have cut them pronounce the stones to be unusually tough, and their extreme hardness will enable them to sustain wear without loss of lustre. Their brilliancy and beauty are certain to bring them into favour with all lovers of true gems. The

different forms of crystal, and their colours, are represented in the accompanying plate.

The author, on visiting the property, mined several thousand carats of gem-stones. Among them he found a very curious crystal of Sapphire with a red stone embedded in the centre. (see plate). The gem-bearing lands are limited to about 7,000 acres, extending along the Missouri River for a total distance of perhaps 15 miles. The Sapphires are most plentiful at or near the bed-rock of the old river-terraces or bars, many of which are from 100 feet to 200 feet above the present channel. These dry river-terraces are for the most part covered with alluvial deposits of sand and gravel, varying from a few inches to 20 feet in thickness. All this alluvial detritus carries gold in paying quantity, and a simple hydraulic apparatus is all that is required to mine rapidly and cheaply for both Sapphires and gold. The local conditions are favourable for the dumps, grade, pressure, and water-supply. It is expected that by next May a process will be in operation whereby both products will be obtained, since it is practicable to adjust the under-current of a common hydraulic sluice so that it shall retain minerals of so high a density as Sapphire as well as the gold.

The rocks in the vicinity of the mines are limestone, quartzite, and dark argillaceous slate, probably of Lower Silurian age. The bed-rock of the bars or river terraces, is a dark, friable slate, broken through by eruptive dykes, in some places hornblendic and dioritic, in other places quartzose. At one point near the river, the dykes appear trachytic and porphyritic, with amygdules and dark mica. At other points the dykes are more like grey lava. Mr. H. A. Miers, of the Mineralogical Department of the British Museum, has described one of the dykes as a

mica-augite-andesite. The dykes contain Sapphires, Garnets, and other minerals, in well-defined crystals and in rounded masses.

It is evident that the denudation of these dykes has set free the Sapphires, and other stones, now found loose in the gravels with the gold. The conditions under which the gem-stones are found in the dykes suggest that the crystallization did not occur there, but in some unknown position previously to the irruption of the dykes. Possibly the original matrix of the Sapphire may have been melted to form the matter of the dykes, whilst the Sapphire itself, by reason of its high fusing-point, remained unmelted. The rounding of the sharp angles and the fracturing of the stones may be observed in those still embedded in the dykes, not less than in those which have been liberated. It is impossible to say what dykes may yet be discovered, or what the many known dykes may produce, when the hydraulic mining is in operation, and all the loose *débris* cleared from the bed-rock.

The author, in the course of mining during his visit, found several small pieces of Ruby broken from other stones; and suggesting, in his humble opinion, that there must be one dyke, or more, amongst others, not yet denuded, containing Rubies of the pigeon's-blood colour. Denundation must have been effected to an enormous extent in order to have furnished the great number of gem-stones found in the alluvial deposits.

The result of the author's personal examination of the Sapphire mines in Montana is a decided impression that they are exceedingly rich, both in precious stones and gold.

SAPPHIRES FROM OTHER LOCALITIES.

Although Corundum occurs in many localities in the United States, besides Montana, it is extremely rare to find it clear enough to be used as a gem-stone. Reference has already been made in the chapter on Ruby, to the Corundum workings known as the Lucas Mine, in North Corolina.

The Sapphire is found in many parts of Australia, but the stones are usually of too dark a colour to be of value. In the drifts of Victoria and of New South Wales, especially in the New England district, Sapphire is not uncommon. Some blue and green Sapphires recently brought to this country from Australia, are believed to have been found in drift-gravels in Queensland. In 1890, it was reported that a fine Sapphire had been found by Mr. T. Bakhop, of Lower Junction, Tasmania, in the north-eastern part of the island.

Sapphires are also known to occur in Borneo, Madagascar, the Ural Mountains, and several other localities. In Europe they are found on the Iser, in Bohemia; in the Sieben-Gebirge, on the Rhine; in Saxony; and in France, notably at Expailly, near Le Puy-en-Valey. The European Sapphires, however, are only of scientific interest to mineralogists, and of no commercial value.

Sapphire.

Composition	Alumina.
Specific Gravity	4, or slightly under.
Hardness	9.
System of Crystallization ...	Hexagonal.
Form	Double six-sided pyramids, or prisms; usually as rolled crystals.

CHAPTER V.

STAR STONES.

CERTAIN varieties of Corundum, especially the greyish-blue semi-transparent Sapphires, when cut *en cabochon*, shew a star of light, more or less perfect, reflected from the convex surface. Such stones are therefore commonly called *Star Stones*, whilst by the Ancients they were designated *Asterias*.

According to Plutarch, the river Sangaris produced a gem called *Aster*, which was luminous in the dark, and was known to the Phrygians as *Ballen*, or "The King." A gem called *Asterites*, found inside a huge fish called "Pan," from its resemblance to that god, is also described by Ptolemy Hephæstion. The term Asteria has been used by different authors in various senses at various times; but there can be no doubt that Pliny understood by it the same gem that we do now. A purplish Star Sapphire was known to Pliny as the *Ceraunia*, or "Lightning-stone," and probably the same stone was termed *Astrapia* (lightning-stone).

The optical phenomenon presented by star-stones is known as *Asterism*, and its cause is to be sought in the internal structure of the crystal; all the Star-stones exhibiting a peculiar laminated texture, and generally presenting, on the basal plane, a system of fine striations related to the direction of the lines of light, which form by their intersection the chatoyant star. In the Star Sapphires there seem to be three sets of structural planes, the edges of which intersect at angles of 60°; and when a transverse section of a hexagonal pyramid is made, these lines are seen as triangular striæ. From each set of parallel lines a narrow transverse luminous band is reflected, and the crossing of these three bands of light produces a star of six rays. Occasionally a secondary system of lines is apparent, thus giving rise to a twelve-rayed star. Great skill is required on the part of the lapidary in dealing with such stones to produce the most effective result.

Although the majority of Asterias are Sapphire, the same optical phenomenon is occasionally exhibited by other gems. The purple and reddish Corundums, when judiciously cut, shew Asterism, thus forming *Star Rubies*; and in like manner *Star Emeralds*, *Star Garnets*, etc.

The Orientals have ever entertained a peculiar veneration for Star Stones, but only of late years have they been of any value in England. The finest Star Ruby lately seen was valued at £200. The price of these gems is mainly determined by quality and colour; small Star Sapphires range from £2 upwards. Star Rubies obtain higher prices; but Star-stones, of a secondary rank, are of little value.

CHAPTER VI.

SPINEL AND BALAS RUBIES.

UNDER the generic name *Spinel* several minerals are included, as the Spinel Ruby, the Balas Ruby, the Pleonaste, and other less valuable varieties.

Differing among themselves in colour and other trivial characteristics, they all agree in possessing approximately the same chemical composition. They are, in fact, aluminates of magnesia, or compounds of alumina and magnesia, associated with small and variable proportions of other metallic oxides, such as those of chromium and iron, to which the colours are probably due.

Few minerals enjoy a wider range of colour than the Spinel. Among its various tints we may mention carmine red, reddish-brown, rose-red, various tints of orange, indigo blue, green, purple, puce, violet, and even white and yellow. Some varieties are opaque and dark-coloured, or even black, but these have no value as ornamental stones. Indeed, it is only the so-called *Precious Spinel*, which is of use to the jeweller. By ancient writers the Red Spinels were probably included, with several other stones, under the general name of *Carbunculus*.

The Precious Spinel is found either detached, as loose pebbles, or embedded in granular limestone, or in granite rocks. In Burma, Ceylon, and Badakshan it occurs in well-formed, sharp-angled crystals which are regular octahedra; while in many gem sands it is found as rolled crystals, accompanied with Zircon, Garnet, magnetic iron ore, and other minerals.

In North America, between Amity in New York, and Andover, in New Jersey, some crystals of extraordinary magnitude have been found, measuring 16 inches in diameter, in company with granular limestone and serpentine; but these are not the precious variety used in jewelry.

The form of Spinel which is generally that of the regular octahedron, enables it to be readily distinguished from the true or Oriental Ruby, with which it has been sometimes confounded. It may also be distinguished by its inferior hardness, and specific gravity.

A peculiarity of Spinel is that the light which is reflected from the depth of the gem, no matter what the colour of the stone, is always of a pale yellow. The lustre is vitreous, and the gem displays every degree of transparency. The refraction is simple. It is rendered electric by friction, but not by heat; differing in the latter respect from Topaz, which is distinctly pyro-electric.

One of the finest specimens of Blue Spinel ever seen in this country was a thickish oblong stone, Indian-cut, weighing $31\frac{7}{8}$ carats. It was re-cut by the late Mr. J. N. Forster, of London, and weighed, after re-cutting, 25 carats. There is a strange history attached to this stone: it was consigned from India as a Sapphire; subsequently it was found to be a Spinel, whereupon the purchaser returned it to the merchant, who at once wrote to the consignor in India, but the statement was not believed. The merchant

determined to have it cut, and afterwards sold it for a much larger sum than it had been valued at as a Sapphire.

In the Exhibition of 1862 there were two very fine Spinels; one from India was cut *en cabochon*, forming an octagon-shaped stone, of perfect colour, and free from flaws. It weighed 197 carats. This was cut by the late Mr. J. N. Forster to an 81-carat "perfection stone." The other Spinel was also an octagon-shaped stone, of perfect colour, very "spread," and free from flaws. It weighed 102¼ carats, and was re-cut by Mr. Forster, weighing after cutting 72½ carats. It is strange that both these stones arrived from India in the same year, viz., 1861.

Spinels of different kinds are found with other gem-stones in Burma, Ceylon, and Siam. In the Ruby mines of Upper Burma, Spinel is a very common mineral, forming in many cases a conspicuous part of the gem-bearing detritus. It is regarded by the natives as the "Mother of Ruby." Fine octahedral crystals have been found embedded in the calcspar, in which the true Rubies occur. It is also found in beautifully sharp octahedra, and in flat hemitrope crystals, of small size, associated with Rubies in the Ruby-earth.

Spinel also occurs in Afghanistan in crystalline micaceous limestone. There are famous mines of Balas Rubies at Badakshan in Usbekistan, a part of Tartary. The mines were known to the Emperors of Delhi. They are near the Oxus, not far from Shighnan. There is a belief among the natives that two large Rubies always lie near each other: thus it is that the fortunate finder of the one hides it until he has found a twin stone; failing this, they are said to break the large one in order to keep up the superstition.

Spinels are found in the Ovens River, in Victoria

while in New South Wales they are by no means uncommon in auriferous deposits, as on the Cudgegong, Peel, Macquarie, Severn and other rivers, where gem-stones are found as rolled pebbles in the gravels.

In Meronitz, in Bohemia, little rose-red crystals occur in company with Pyrites; the mineral is found also in Transylvania, in gold sands. At Aker, in Sweden, pale-blue and grey varieties occur embedded in limestone. None of these are of any value to the jeweller.

The *Balas* or *Balais* Ruby, is a pale-red or rose-red Spinel, with a tinge of blue appearing at the angles of the octahedron, which gives it a milky kind of shimmer and depreciates its value. The colour is probably due to chromic acid. The name "Balas" or "Balaksh" applied to this stone, is said to be a corruption of Badakshan, one of the localities which, as stated above, yields the Spinel.

Pleonaste is an opaque black variety, which was called *Ceylonite*, by Romé de l'Isle, who analyzed it with a number of other crystals brought from Ceylon. It was Haüy who, seeing its form resembled that of the Spinel, desired to give it a special position in his system of minerals, and named it *Pleonaste*, which signifies superfluity. Further investigation showed that it was in reality a black Spinel. This has the best cleavage of the whole class, being easily cleaved parallel to the faces of the octahedron. It may contain as much as 20 per cent. of protoxide of iron. It is found in Ceylon, Russia, Norway, Bohemia, and at Monte Somm . ; but it is never used as an ornamental stone.

The transparent Spinels, in consequence of their lustre, and colour, are used for personal ornament, and for objects of luxury; but it is only when the crystals are fine and large that they are considered gems. In cutting it receives the same form as the Ruby.

In the inventory of the French Crown Jewels, in the year 1791, we find the following values; but it should be stated that at the present day the stones would not fetch one-tenth of such prices.

One Spinel Ruby of	$56\frac{3}{4}$	carats	...	£2,000
One „	$4\frac{2}{8}$	„	...	£12
One „	$3\frac{3}{4}$	„	...	£12
One Balas Ruby	$20\frac{5}{8}$	„	...	£400
One „	$12\frac{3}{8}$	„	...	£120

Even to-day specimen stones may attain high prices, but generally the Spinels are not much cared for.

Spinel.

Composition—Alumina	... ...	72
Magnesia	... ...	28
		100

Specific gravity—

Varies from 3·59 in an aurora red specimen to 3·71 in one of indigo blue colour. (Prof. Church).

Hardness... 8

System ... ... Isometric or Cubic.

Form ... Octahedron, and as rolled pebbles.

CHAPTER VII.

THE EMERALD.

THE Emerald, from a mineralogist's point of view, belongs to a class of stones altogether different from that which embraces the precious stones already described, inasmuch as it is essentially a mineral silicate, consisting largely of the substance known to chemists as *Silica*. The silica is itself an oxide of an element termed *Silicon*, which is closely related in many ways to carbon. In the Emerald the silica is combined with the oxides of two metals—one of them being *aluminium*, the basis of the Ruby and Sapphire; while the other is an exceedingly rare metal, known as *glucinum* or *beryllium*. The former name is derived from the sweet taste of some of its compounds—from the Greek word for "sweet"—whilst it receives the latter from its occurrence in the Beryl.

Just as it was shown that the Ruby and the Sapphire are identical, save in colour, so the chemist has found that the Emerald, the Beryl, and the Aquamarine are practically the same mineral, the distinctions between the three varieties being due to differences of colour and other characteristics of only trivial value to the chemist, though of immense importance to the jeweller as affecting their commercial value.

That the true Emerald was known to, and held in estimation by, the Ancients, may be inferred from the fact that ornaments of Emeralds have been excavated from Pompeii and Herculaneum; that similar ornaments have been dug up from the ruins of old Rome, and have also been found on Egyptian mummies. Although Gesenius does not admit that the words translated in Exodus and elsewhere, *Emerald*, really describe the modern gem, yet the beautiful green mineral so called was, as some mummies prove, employed as an Egyptian ornamental stone in the time of Moses.

There is no doubt that the ancient Egyptians worked the Emerald to a very large extent. Pliny and Strabo allude to some old Emerald mines near the Arabian Sea, and M. Cailliaud when sent by the Viceroy or Pasha of Egypt on an exploring mission discovered these ancient workings. He found many of the caves or mines so large that 400 men could work together in them; and, that they had been worked of old, he deduced from seeing their ropes, levers, lamps, and tools of various kinds. These mines have recently been visited, as will be explained subsequently, by Mr. E. A. Floyer.

Pliny further states that the Emerald stood high in the estimation of the Ancients, and some confirmation of this is derived from an old Hebrew tradition that if a serpent fixes its eyes on an Emerald it becomes blind. In the Bible the rainbow is said to be "like unto an Emerald."

There can be no doubt that many ancient writers confounded under the general term *Smaragdus* several distinct minerals of green colour, such as true Emerald, green Jasper, Malachite, Chryscolla, green Fluor Spar, and perhaps even green glass.

According to Pliny, the most celebrated Emerald

mines in former times were in the rocks near Coptos; and the stones obtained from this region were admired for their brilliant colour. Mohammed Ben Mansur (13th century) describes the Emerald mines as being on the borders of the land of negroes, and yet belonging to the kingdom of Egypt, the stones found there being dug out of talc and red earth. De Laet thinks that the same region supplied Emeralds as late as the 17th century.

Isidorus, Bishop of Seville (640 A.D.), says of the Emerald, "that it surpasses in its greenness all green stones, and even the leaves of plants, and that it imparts to the air around it a green shimmer; that its colour is most soothing to the eyes of those engaged in cutting and polishing the stone."

That the green colour of the Emerald was recognized long ago as being refreshing to weak eyes is seen by reference to Pliny's gossiping pages:—"If the sight hath been wearied and dimmed by intentive poring upon anything else, the beholding of this stone doth refresh and restore it again."

Psellos, in the 11th century, says of the Emerald, "that it is leek green, playing easily into gold and blue; and that it has power, when mixed with water, to heal leprosy and other diseases."

Pliny relates in illustration of the radiancy and lustre of the stone to which he gives the name of *Smaragdus* "that in the island of Cyprus there is placed on the tomb of King Hermias a lion sculptured in marble, and, for the eyes, Emeralds were let in, which shone so brightly on the surrounding sea that the 'tunny fish' were frightened away, and that the fishermen, observing this with dismay, removed the Emeralds from the lion, and replaced them by common stones not having so much brilliancy." It is not

likely that a stone of such beauty and value as the Emerald would be used to represent eyes in a large statue in the open air; and we are driven, therefore, to the conclusion that it was some other mineral of a green colour—probably a green copper ore, such as Malachite, since ores of copper were common in Cyprus, while the true Emerald is unknown there, notwithstanding the frequent reference of certain writers to the Cyprian Smaragdus.

The tiara of Pope Julius II. contained an Emerald somewhat above an inch in length and one-and-a-quarter thick. It was in the shape of a short cylinder, rounded at one of its extremities. This was found probably in Ethiopia, the modern Etbai.

Turning to the Emeralds of the New World, we find Prescott, in his "Conquest of Mexico," writing as follows (vol. i, p. 125):—"The age of iron has followed that of brass, in fact as well as in fiction. They found a substitute in an alloy of tin and copper, and, with tools made of this bronze, could cut not only metals, but with the aid of a siliceous dust, the hardest substances, as Basalt, Porphyry, Amethysts, and *Emeralds*. They fashioned these last, which were found very large, into many curious and fantastic forms." Elsewhere (vol. iii., p. 214), in describing certain spoils, he mentions a large Emerald "cut in pyramidal shape, of so extraordinary a size, that the base was as broad as the palm of the hand." And in another place (p. 287) mention is made of fine Emeralds of a wonderful size and brilliancy. These had been cut by the Aztecs into the shapes of flowers, fishes, and other fantastical forms, "which Cortèz gave to Doña Juana de Zuñigar, on his second marriage, causing jealousy to the then-reigning Queen."

In the Manka Valley of Peru the natives appear to

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THE SOUTH AMERICAN EMERALD in Matrix.

have paid divine homage to a magnificent Emerald of the size of an ostrich egg, which they named the goddess of Emeralds. The priests enhanced the value by displaying it on high festivals only, when, it was alleged, Emeralds were peculiarly acceptable to the idol, and thus the temple came into possession of a vast number of these costly gems, which on the discovery of Peru by the Spaniards fell into the hands of the conquerors; but Pizarro and his followers, "like bad lapidaries" writes Purchas, broke many to fragments, supposing they would possess the adamantine property of the Diamond or Ruby. There has been doubt thrown on this goddess of Emeralds, many suggesting that it was more probably a Beryl, or perhaps an Aquamarine, which, though closely allied chemically, is not identical with the true Emerald, or one hundredth part of the value of a fine stone.

After the discovery of Peru, Emeralds became less rare in Europe, and jewellers and lapidaries much preferred the Peruvian stones; hence the most beautiful of Emeralds are always called Peruvian or Spanish Emeralds. Joseph D'Acosta, who himself visited the Emerald mines of New Granada and Peru, said that at first these stones came to Europe in such numbers, that on the ship in which he returned from America to Spain, in 1587, were two chests, each containing one hundredweight of Emeralds. Most of the Emeralds now come, as will be subsequently explained, from, near Santa-Fé de Bogata, in the Republic of Colombia.

The Emerald is found crystallized in six-sided prisms or columns, without striations, and, therefore, unlike those of Beryl, and without any inclination to the cylindrical form. The colour varies from what is called emerald-green, to grass-green, and greenish-white. Subjected to

the dichroiscope, its colour is resolved into a yellowish-green and a bluish-green.

The variety of opinion as to the source of the beautiful colour of the Emerald is very interesting. According to most authorities it owes its beauty to the chromium which it contains. On the other hand, M. Lewy, who analysed with great care the Emeralds from the Muzo mines of Colombia, found that they contained organic matter in the form of some hydro-carbon, a simple combination of carbon and hydrogen, and that the intensity of the colour depended upon the amount of this organic matter contained in the Emerald. The green pigment of the Emerald was supposed by him to be similar to the colouring matter of leaves, called chlorophyll. Of protoxide of chromium he found but 1 per cent. Blum, experimenting upon the Emerald, exposed this stone for four minutes to an intense heat, and then threw it into water, the consequence of which was that it fell into several pieces, some of which were of a black, and others of a greenish tint. The conclusions of M. Lewy have not, however, been verified by other chemists; and the experiments of the late Mr. Greville Williams and others rather tend to shew that the green colouring matter of the Emerald is, after all, an oxide of chromium.

The *cleavage* of the Emerald is in four directions, but the only perfect cleavage is that parallel to the terminal plane. Its *fracture* is conchoidal and uneven, and its *lustre* vitreous.

It is doubtful if Emeralds have ever been found in India; though they are sent there, in the rough, from other localities, and after having been cut in India, are forwarded to this country for sale. Having been manipulated by native lapidaries, when they come to our markets

they have to be re-cut. The Beryl is found in Madras, in Rajputana, in Orissa, and a few other localities in India, but not to any extent, or of fine quality. It is said that, in Burma, Emeralds have from time to time been picked out of the sand or beds of small rivers. In the treasure from Mandalay, now in the South Kensington Museum, are some very large Emeralds, but they are probably from South America. The Emerald is a favourite stone throughout India, and is consequently imported. The Sultan of Oude presented the Queen with an Emerald as large as a moderate-sized hen's egg, but its original locality is unknown.

The Ural and Altai Mountains have of late years furnished true Emeralds. The first stone was found accidentally, in 1830, by a charcoal burner, at the root of a tree on the east side of the Ural. This discovery led directly to the regulated working of the bed, which yielded in the first year some fine specimens—one of the extraordinary weight of 101½ carats; but, unfortunately, the yield gradually decreased. Very fine crystals of Emerald are found in mica-schist at Stretnisk, on the river Takowja, which lies to the north of Katherinenburg, on the Asiatic slope of the Urals. The Emerald is there worked commercially.

The mineral also occurs in the mountains of the Sahara, in beds of mica-slate; and in the bed of the River Harrach, in Algeria, where it joins the River Oued Bouman. In the latter, Emerald-crystals have been found in white lamellated limestone.

Emeralds have been recorded from several localities in New South Wales, but they are rare, and usually of no commercial value. Quite recently, however, a discovery of this gem, which may be of some importance, has been

reported from Vegetable Creek, where the Emerald occurs in a vein of topaz-rock, associated with tinstone and arsenical mundic, near the junction of granite and claystone.

The chief European locality yielding good crystals o Emerald is the Heubachthal, in Salzburg, where the mineral occurs embedded in mica-schist, much as it is found on the Ural Mountains. It is also found at Snarum in Norway.

But the most famous Emerald mines of the world are those of Muzo, situated in 5° 39′ 50″ N. latitude, and 74° 25′ W. longitude, about 75 miles N.N.W. of Santa Fé de Bogata, in the Republic of Colombia. They were discovered by Lanchero in 1555, but the Spaniards did not commence working until 1568. They are now worked by a company, who pay an annual rent of 24.000 dollars to the Government. Their lease will expire in 1896, but they have the option of renewal for another ten years.

Workings at the Muzo Mines were stopped in the middle of the last century, and it was rumoured that fires had broken out, and that the mines were unsafe. It was not until 1844 that active operations were resumed. About that time a Colombian named Paris—after whom the rare mineral *Parisite* was christened—got out some fine stones and sold them for large sums in Europe and in the United States. A French company was afterwards formed, and during the Empire all the finest stones went direct to the Paris market.

The great Muzo mine has the form of a tunnel of about 100 yards deep, with very inclined walls. On the summit of the mountains, and quite near to the mouth of the mine, are large lakes, whose waters are shut off by

means of water-gates, which can be easily shifted when the labourers require the water. When the waters are freed they rush with great rapidity down the walls of the mine, and on reaching the bottom of it they are conducted by means of an underground canal through the mountain into a basin.

The matrix of the Emerald is a bituminous limestone, rich in carbon, deposited on red sandstone and clay slate, and believed to be of Neocomian age. To obtain the Emeralds the workmen begin by cutting steps on the inclined walls of the mine, in order to make firm resting-places for their feet. The overseer places the men at certain distances from each other, to cut out a wide step with the help of pickaxes. The loosened stones fall by their own weight to the bottom of the mine. When this begins to fill, a sign is given to let the waters loose. These rush down with great vehemence, carrying the fragments of rock with them, through the mountain into the basin. This operation is repeated until the horizontal beds are exposed, in which the Emeralds are found. The Emeralds are sometimes accompanied by beautiful crystals of iron-pyrites, and now and then by crystals of Parisite. An Emerald is not unfrequently found in fragments which, when placed together, form one beautiful crystal. Another remarkable circumstance is that the Emeralds break shortly after being separated from the matrix. This is sometimes prevented by a little foresight, shewn by placing the stones in a vessel for some days, and protecting them from the rays of the sun.

The Emeralds occur in pockets, and the mining is consequently very precarious ; for some time the workings may be unremunerative, and then suddenly a discovery of good stones may reward the adventurer.

Other workings for Emeralds have of late years been undertaken within a short distance of Muzo, but it does not appear that any of these have yet proved remunerative. The geological conditions may be similar, but the fine Emeralds, so far as we know, are wanting.

The value of an Emerald depends greatly upon its colour, and freedom from flaws; a very fine dark velvety coloured stone, free from flaw, is seldom procurable. Perhaps there is no stone which suffers more than the Emerald from inequality of structure, colour and transparency, and from clouds and spots.

Fashion greatly influences the value of the Emerald. When retained to enhance the price, it yields to the potent attraction of other first-class gems, and the demand subsides; but when freely admitted into the market, the taste often revives.

In the early part of this chapter it was pointed out that Emeralds had been largely worked at a very distant period in certain parts of Egypt. Since M. Cailliaud's workings were abandoned, more than seventy years ago, very little has been heard of these historical mines; but in the course of an exploring expedition in Eastern Egypt, despatched by H. H. The Khedive last spring, the old workings were examined, and specimens of the rocks and minerals were collected. For the following description I am indebted to the courtesy of Mr. E. A. Floyer:—

THE EMERALD MINES OF EGYPT.

"Non procul ab urbe Assuan ad latus Nili meridionale est etiam mons alius, cujus in radicibus extat fodina Smaragdi, in deserto ab œdificiis remoto. Nec reperitur in toto terrarum orbe Smaragdus aliunde quam ex hac fodina, quæ sane fossoribus perfrequens est; ex hac enim eductus distrahitur postea in partes Universus." *Idrisi, trans. by Blageart,* 1619.

The emerald mines of Egypt were visited this year

(1891) for the first time since their hasty abandonment by Muhammad Ali in 1819.

The scientific expedition to the Northern Etbai, despatched by H. H. The Khedive made a somewhat detailed examination of them, and brought home maps and samples of ore containing crystals of emerald.

These are probably the earliest known emerald mines in the world. Though mentioned by the ancient historians Strabo, Diodorus, Agatharchides, and others, no description of them appears to have been written from actual examination. This probably arose from the difficulty of visiting them. Olympiodorus laments his ill success in this direction, and it is probable that a jealous watch was kept over the miners.

The emeralds of Egypt, are, however, often mentioned with high praise. Cleopatra gave, as presents to ambassadors, portraits of herself engraved on emeralds, and the stones during her reign appear to have been considered as strictly royal property.

Maundeville, 500 years ago, described Egypt as "a country of fair Emeralds."

When and under what circumstances the mines were abandoned must remain matter of conjecture. They probably shared the fate of the numerous gold mines and topaz workings which are found in their neighbourhood.

All the mines in Egypt appear to have been first worked by some unskilled people, possibly those negroid tribes, who now work the copper and iron mines in the Soudan; who forged the spears during the Mahdi revolution; and who are now, in the fastnesses of their metal-bearing mountains, making head against the fanatical outburst which at first swept them off their feet. It was to these people that Herodotus, not knowing why they

burrowed in the earth, gave the name of Troglodytes or cave dwellers.

These people were probably driven south about 2,000 years ago by the Greek miners employed under Ptolemy after the death of Alexander the Great. At each mining town may still be seen the open-air cuttings and the rude stone dwellings of an ancient mining people. And close by these are found in almost every case, the temple, the well-built rectangular houses and covered galleries of their European supplanters. There is hardly a quartz reef which does not bear marks of working.

The emerald mines are in the centre of a great mineral field formed by a depression in the long range of mountains which runs along the Red Sea Coast.

To the north, in latitude 27°, this range rises into the great porphyry peaks whence Mr. Brindley brings the Imperial stone which the Romans prized—and now the English prize so highly—for purposes of decoration.

The range is then hollow-backed, until in latitude 24°, the traveller climbs the lofty porphyry peaks of Hullus, and, seated on the edge of a wall, sheer 1,500 feet, looks over a hundred miles of sea and mountain.

Between these points, and, equally between Hullus and Elba, to the south, the hills are honeycombed with gold mines and scarified by topaz workings; the last are still in progress.

But the most interesting part of the range is that in which are found the emerald mines of Sikait and of Jebel Zabbara, the latter word possibly a corruption of Smaragdus.

There are two main emerald mining centres. That of Sikait approached from the sea by the Wadi Jamal is the largest and most extensive. Here are very ancient

rock temples. The priests of old reaped a rich harvest from the superstition of the miners. Some Greek inscriptions from these temples are now being deciphered by the Rev. Canon Wright of Coningsby.

Of a later date than these rock temples, is a good masonry temple, admirably proportioned, roofed in part with great slabs of shining schist, and imposingly placed on a spur of rock running into the Sikait valley. Here are the ruins of a well-built town, and along the valley and in all the hills are some hundreds of shafts of varying depth. The hills, some 600 or 700 feet in relative height, are mainly formed of a soft talcose schist veined with quartz and consolidated by contorted beds of a brown brittle metamorphic rock. It is probable that the schist is formed from the blue clay beds which occur under the Nubian sandstone which once floored the great Eocene Sea.

The hills bear the appearance of a great rabbit warren. Everywhere are holes, each with its talus of silver-grey powder streaming down the hillside. The talc occurs in solid white blocks, coloured green, coloured slate, and often bright yellow like gold. When climbing the hills the feeling underfoot is that of walking on soft dead wood. Square towers mark the mountain tops. Some were watch towers, whence the watchmen guarded the miners and gazed over the blue sea looking eagerly for the expected ships of wine and food. Other towers appear to have been magazines.

Some ten miles north of Sikait are the Jebel Zabbara mines. Here the principal shafts are in low spurs, doubled up in syncline and anticline in rapid repetition, and jutting from a mass of schist some 1,200 feet in relative height.

Here, among the ruins of the old houses are the stone

houses and ovens of the Albanian miners who in 1819 were placed by Muhammad Ali under the supervision of Cailliaud, a young French silversmith who earned, later on, great réputation as traveller and mineralogist in the Soudan with Ibrahim Pasha.

Cailliaud's account of his discovery of these mines has been published by the French Academy. Why they were abandoned is nowhere stated, but it was probably owing to Cailliaud being commanded to accompany the expedition to the Soudan, and to the stoppage of supplies to the miners the moment his presence was removed.

These Albanians did an immense amount of work if they did all that has been done. In one valley the silvery talus cannot amount to less than 20,000 or 25,000 tons. They made good square-sectioned shafts.

Across them are wedged stout boughs of trees. Mr. Floyer descended one shaft and took out string to the length of 450 feet. The descent was a steep incline with occasional perpendicular drops of six to ten feet. At this depth was a chamber where were ranged some thirty baskets of ore all ready for raising to the surface. It was difficult to believe that the baskets were seventy years old. From the chamber radiated further galleries which were not explored. [One of these baskets, containing the ore, or talcose schist, from which the Emeralds were derived, is now in the author's possession, having been presented by Mr. Floyer, who had it sent direct from the Egyptian mines.]

Near these mines is good water. Arabs frequent the place with sheep and donkeys ; and a further exploitation, assisted by steamers calling at intervals, does not seem to present much difficulty.

Emerald.

Composition—Silica	... ...	68
Alumina ...	... ...	18
Glucina, &c.	... ...	14
		100
Specific Gravity ...	.. ..	2·7
Hardness	... ...	7·5
System ...	... ...	Hexagonal.

Form Hexagonal and di-hexagonal prisms. variously modified.

CHAPTER VIII.

THE TRUE OR ORIENTAL CAT'S EYE.

CHRYSOBERYL.

MUCH confusion exists concerning this very curious and valuable gem, a confusion arising partly from the ignorance of many in the trade as to its true nature, but principally from the mistakes of those who have written about it. In mineralogical treatises it is often confounded with, and described as, a peculiar variety of Quartz, which somewhat resembles it, but which is of little or no mercantile value, although it has occasionally been sent to Europe by unscrupulous merchants as the true Cat's Eye. This chatoyant quartz is found largely in Ceylon, and on the west coast of India, where it is known as "Coast Cat's Eye": it occurs chiefly of various shades of yellow, or brown. A greenish variety is found near Hof, in Bavaria, and is largely cut as an ornamental stone. The Quartz Cat't Eye is semi-transparent, and when cut in a convex form (*en cabochon*) shows a more or less defined band of light, with a *silky* lustre, resulting from a reflection of the

CHRYSOBERYL CAT'S EYE, in the Rough (Part Polished).

fibrous grain of the stone itself, or more probably from an intimate admixture of asbestos, which penetrates the quartz in delicate parallel fibres. This Quartz Cat's Eye, even when most perfect, cannot be compared for beauty with the real or Oriental Cat's Eye, for which, side by side, it ought not to be mistaken, even by the uninitiated. It is at once distinguished by its inferior hardness, lower density, and want of brilliancy. It has, like the Cape Cat's Eye, little or no commercial value. It may be useful to contrast the characteristics of the two minerals :—

Description of true (Chrysoberyl) Cat's Eye.	*Description of Common Quartz Cat's Eye.*
Colour—Various shades of yellow, brown, green and black.	Colour—Various shades of yellow, greyish green and brown only.
Ray—Iridescent.	Ray—Dull.
Lustre—Brilliant.	Lustre—Dull.
Hardness ... ... 8·5	Hardness ... ... 7.
Specific Gravity ... 3·8	Specific Gravity ... 2·6.
Infusible before the blowpipe, and not affected by acids.	Melts with Soda to a clear glass. Soluble in Hydrofluoric Acid.
Sometimes shewing a beautiful dichroism.	Never dichroic.
Approximate Chem. Com. { 80 alumina, 20 glucina; colouring matter—oxide of iron	Chem. Com. { 48 Silicon, 51 oxygen, with a small amount of oxide of iron and lime.

The true or Oriental Cat's Eye is a rare variety of the *Chrysoberyl*, or *Cymophanc*—a stone of extreme hardness, in this respect being only inferior to the Diamond and the Sapphire. It is characterized by possessing a remarkable play of light in a certain direction, resulting, it is supposed, from a peculiarity in its internal structure, which appears to be minutely striated. This ray of light, or "line," as it is termed by jewellers, shines in fine and well-polished specimens with a phosphorescent lustre. In India the lines of light are called *betas*, aud the price increases according to the number of these "betas."

The true Cat's Eye (Chrysoberyl) comes principally from Ceylon, where it is found in company with Sapphires, Zircons, and other gem-stones. It is of various colours, ranging from pale-straw colour through all shades of brown, and from very pale apple-green to the deepest olive. Some specimens, much sought for by Americans, are almost black. The line, no matter what ground-colour the stone may possess, is nearly always white, and more or less iridescent; occasionally, but very rarely, however, the line is of a golden hue. This lustre is most beautiful when seen in full sun-light, or by gas-light, when the lines become more defined and vivid.

This gem is valued principally according to the perfection and brilliancy of the luminous line, which should be sharp and well-defined, not very broad, and should run evenly from end to end across the middle of the stone. The colour does not much influence the value, some jewellers preferring one tint, some another. On the whole, perhaps, the most popular colours are the clear apple-green and dark olive: both of these form a splendid back-ground, and contrast well with the line. It is quite impossible to give any satisfactory scale of values for this gem, its

estimation depending much on personal appreciation and taste.

In India it has always been much prized; it is held in peculiar veneration as a charm against witchcraft, and is the last jewel a Cingalese will part with. The specimens most esteemed by the Indians are those of a dark olive colour, having the ray so bright on each edge as to appear double. It is indeed wonderfully beautiful with its soft, deep colour, and mysterious gleaming streak, ever shifting, like a restless spirit, from side to side as the stone is moved; now glowing at one spot, now at another. No wonder that an imaginative and superstitious people regard it with awe and wonder, and believing it to be the abode of some genii, dedicate it to their gods as a sacred stone.

A great deal of so-called Cat's Eye has of late years been brought from South Africa. The stone usually presents rich golden tints, or various shades of brown, but occasionally offers a red or even a blue colour. This mineral will be described at length under the heading "Crocidolite," the name by which it is often known. It is in fact a fibrous form of Quartz, in most cases replacing Crocidolite, and thus forming what mineralogists call a pseudomorph. This African Cat's Eye—or, as it is sometimes termed Tiger's Eye—has been brought from Griqualand in masses of sufficient size to be made into snuff boxes, and other ornamental objects; while slabs of the stone have been used as veneer to cover the tops of small tables. The slabs are, however, much less effective than pieces cut with a convex surface.

It will have been gathered from the foregoing remarks, that no fewer than four different stones are known under the name of Cat's Eye, namely:—

(1.) The fibrous variety of Chrysoberyl.

(2.) The Chatoyant Quartz from India.

(3.) The green asbestiform variety from Bavaria.

(4.) The brown "Crocidolite" from South Africa.

But it must be borne in mind that the only one as a gem of real value is that which has been described above as the *true* or *Oriental* Cat's Eye—a fibrous variety of Chrysoberyl—far surpassing in hardness and beauty any of its namesakes.

ALEXANDRITE, in the Rough.

CHAPTER IX.

ALEXANDRITE.

THIS stone, which was named after the late Czar of Russia, having been discovered on the birthday of Alexander I., owes its celebrity to its prominent hues of *red* and *green*. The Russian Alexandrite can rarely be shown to the best advantage in consequence of its radical defects of structure, as it is flawed with crevices and rents which make successful cutting and polishing extremely difficult. The variety found in Ceylon is more easy of manipulation.

Alexandrite is especially remarkable for its strongly marked difference of colour, according as it is viewed by natural or by artificial light. The finest stones present a bright green, or deep olive green colour, by daylight; whereas at night, artificial light, such as that of gas or a candle, brings out a soft columbine red or raspberry tint.

A small amount of chromic oxide gives to the stone its green colour in daylight; while it contains a trace of copper and oxide of lead, sufficient to impart a dark-red colour to it when exposed to artificial light. By daylight these two colours intermingle, the green predominating. If the stone be turned towards the setting sun, or towards a flame, the red predominates.

The Alexandrite is strongly dichroic, while some varieties are even trichroic. In a dull light, in the direction of the long diagonal of the base, a faintish oil-green is reflected, but in that of the chief axis the tint becomes a deep verdigris. The orange-yellow, dark emerald, and medium columbine red, can only be observed in a clear white light.

Chemical analysis shows that the Alexandrite is a variety of Chrysoberyl. The author has seen, in the course of his experience, two or three stones with a perfect Cat's Eye line, yet subject to the characteristic change of colour by artificial light: such stones are called *Alexandrite Cat's Eyes.* In order to display the line of light, it is necessary to cut the stone *en cabochon* instead of facetting it.

The original Alexandrite came from the Ural mountains only in small quantities; but the principal supply now, is obtained from Ceylon, where, however, it is far from plentiful. The market value of this stone is extremely variable.

Alexandrite.

Composition:—	
Alumina	79
Glucina	18
Iron and chromic oxide, &c.	3
	100
Specific Gravity	3.7
Hardness	8·5
System of Crystallization ...	Trimetric
Form of Crystal	Usually six-sided twins.

CHAPTER X.

THE OPAL.

NICOLS in his curious old book entitled "A Lapidary," written nearly two centuries and a half ago, gives a quaint description of this lovely stone. He says, "The Opal is a Precious Stone which hath in it the bright, fiery flame of the Carbuncle, the fine, refulgent purple of an Amethyst, and a whole sea of the Emerald's green glory; and every one of them shining with an incredible mixture and very much pleasure." Boetius describes it as "the fairest and most pleasing of all other jewels, by reason of its various colours." Cardanus says, "I bought one for 15 crowns, which gave me as much pleasure as a Diamond of 500 aureos." Onomacritus, writing 500 years B.C., remarks, "The delicate colour and tenderness of the Opal remind me of a loving and beautiful child." According to Pliny, "It is made up of the glories of the most precious gems, and to describe it is a matter of inexpressible difficulty."

In all these notices of the Opal, prominence is naturally given to the brilliant play of rainbow tints which renders this stone unique. Although possessing no colour which can properly be called its own, it exhibits flashes of

the most vivid hues. This is probably the result of the number of fissures which traverse it, the light being decomposed by the delicate striations on the walls of these microscopic crevices, thus giving rise to the optical phenomena known as "diffraction." The optical properties of the Precious Opal have frequently been made the subject ot study by physicists in this country, notably by Sir David Brewster, by Mr. William Crookes, and quite lately by Lord Rayleigh.

In some varieties the colours are more or less evenly distributed, and one set of shades will predominate in one part of the stone, and other colours in another part; or the distinct tints will run in parallel bands. In other specimens the colours are made up of small regular angular patches of every hue, and these polychromatic stones are known as *Harlequin Opals.*

The Opal is a non-crystalline mineral. When first taken out of the earth it is not very hard, but subsequently, by exposure to the air, its hardness is increased: nevertheless, it always remains a soft stone compared with other gems. Before the blow-pipe the opal is infusible, but the water driven off by heat renders it opaque. It has the curious property of improving by the warmth of the hand, which brings out the brilliant tints for which this stone is so famed.

Several kinds of Opal are known to the mineralogist. Most of it is destitute of beauty, and hence useless to the jeweller. This is known as *Common Opal.* Other specimens present translucency, but no colour; these are distinguished as *Semi-Opal.* Certain Opals from Zimapan, in Mexico, possess a bright orange-red tint, and are used to a limited extent as an ornamental stone under the name of *Fire-Opal.* But the beautiful variety which is familiar

to every one by its unique colours is distinguished as *Precious* or *Noble Opal.*

The Precious Opal, used in *bijouterie*, was formerly obtained almost exclusively from Hungary. It was called *Oriental Opal* by the Greek and Turkish merchants, who obtained it from the celebrated mines of Czerwenitza, and carried it to the East for the purpose of giving the title Oriental to it, which always conveyed a sense of goodness and value to stones. If Opal were of Oriental production, it would be a somewhat singular fact that Dhuleep Singh, on re-visiting that Empire, carried two Opals to his mother as a gift that should bear the charm of novelty.

The mountain range in Hungary, where the Opal is found, consists mainly of a kind of trachytic rock, or porphyritic andesite, which likewise yields lead, silver, and gold; and, near the Czerwenitza district, traces of quicksilver also occur. The two highest mountains of this range are Simonka and Libanka, and it is from these that the Precious Opal comes, especially from Dubrick. There seems no doubt that the Opal mass, originally in a liquid or gelatinous condition, filled up the cavities in the trachyte veins and was gradually solidified.

The Mexican Opal occurs at several localities, notably in the State of Queretaro, where brown and amber-coloured varieties are found. White opaque Opal is worked at Huitjuco mine in the State of Guerrero; and a transparent Opal, with red fire is obtained from Esperanza.

Opal is also found in Honduras, in the Department of Gracias, and in Guatemala. Most of this Central American Opal is more transparent and less fiery than that from Hungary, but the conditions of its occurrence seem to be very similar in the two localities. Very little of it comes into the market.

Of late years Precious Opal of singular beauty has been found in Queensland, occurring as thin veins in brown ironstone on the Barcoo River. Indeed, the Opal-mines of Queensland bid fair to rival, at no distant day, the far-famed depositories of this gem in Hungary. Attention was first directed to the Queensland Opals by Mr. Bond, who found them near Coopers' Creek. They have since been discovered in sandstone in the northern part of Mount Tyre, on Mount Marlow Station.

Opals have also been found in New South Wales, and in many other localities; but in many cases they are too thin to be of any great value. Fine Opals, however, are known to occur at the White Cliffs, on the Moomba run, in County Yanulgra, about 160 miles E.N.E. of Broken Hills. At this locality they were accidentally found a few years ago by Mr. G. J. Hooley, in tracking up a wounded kangaroo. The Opal is disseminated through a sandstone rock, corresponding to the Desert Sandstone of Queensland, and it also occurs as the mineralizing material of fossil shells and silicified wood.

Opals have sometimes been engraved, but the work requires great care on account of the numberless fissures in the stone, which it is dangerous to open to the air. The oldest example is an intaglio, on a moderately large Opal, of the portrait of Louis XIII. when he was a child. The head of Juba is engraved upon an Opal in the collection tion of the Duke of Orleans.

The Queensland Opal is now largely used for cameos, the brilliant colours of the gem forming a marked contrast to the dark background afforded by the ironstone matrix.

The Hungarian Opals exhibit a uniform milkiness of surface, more or less iridescent. From their greater density they resist the effects of wear longer than any

other sort, hence their superior value. The Mexican stones are beautiful, but so porous that if wetted they become colourless, and very frequently, after some little wear, turn opaque and brown ; they have, therefore, but little commercial value. A few years ago Hungarian Opals were sold by the piece ; now they are sold by the carat.

There is a strange history given by Pliny of an Opal about the size of a hazel nut, which was possessed by the Senator Nonius, and was valued at £20,000 of our money. Nonius, who was proscribed by Marc Anthony for the sake of this gem, made his escape, carrying off the ring with him, as the sole relic of his fortune. He preferred exile with his Opal to living in Rome without it.

The two largest specimens of "Noble Opal" known in this country were found in the Hungarian mines in 1866; and were exhibited by the late Madame Goldschmidt in the Paris International Exhibition of 1867. Both stones were of the "drop," or pear-shape form, one weighing 186 carats, the other 160 carats ; this latter, a magnificent "Harlequin Opal," is reputed on good authority to be one of the finest known gems of its class. The Hungarian mines are now worked by Mr. Egger, of Vienna.

There is, in the Imperial Cabinet of Vienna, an Opal nearly as large as a man's fist, and weighing 17 ozs. Perhaps the finest Opal of modern times was that of the Empress Josephine, which was called the "Burning of Troy," from the numberless red flames blazing on its surface: the obverse was opaque, a peculiarity specially observed in the Honduras Opal.

There were some very valuable specimens of Opal in the Hope collection—first, one an inch in length, and one inch and three quarters in width, highly transparent, and very rich in colour. The chief reflected rays were green

and yellow, interspersed in different directions with flashes of bright blue and deep red. A representation of Apollo's head, surrounded by rays of fire, is engraved upon it in *alto relievo*. In all probability this stone is of great antiquity. It may have been intended as the idol symbolizing the "Sun," and been given to some Persian Temple, dedicated to that god, but its transparency suggests a Mexican origin, whilst the fine engraving and mounting in gold and black enamel indicate Persian workmanship.

The second specimen is a translucent emerald-green Opal in its matrix, from Mexico. It has the remarkable property of becoming quite opaque when heated, and of recovering its translucency on cooling.

It is well known that there are innumerable superstitions attached to the Opal. By the Ancients it was thought to bestow every possible good. In the Middle Ages the same belief was held ; and in the early part of the seventeenth century the Opal was much more valued than at the present day. But by a strange freak of fashion the Opal lost its pristine glory, and for a long time was falsely accused of bringing ill-luck—a bad reputation which it has hardly yet lost. Sir Walter Scott is said to be in a great measure answerable for this, as readers of *Anne of Geierstein* know. It seems strange that in this enlightened nineteenth century there should still be people believing in the bad fortune supposed to attend the wearing of Opals. I think however, that it may perhaps be explained by the softness and brittleness of the stone ; it being very easily scratched when rubbed, while it breaks more readily than any other gem-stone. Yet withal it is a favourite stone with the Queen, the German Royal Family, and with many of our aristocracy. Without doubt the stone will ere long be as much

QUEENSLAND OPAL in the Matrix.

appreciated as it was in earlier times, for the foolish idea about ill-fortune must inevitably go the way of all superstitions. The Americans have already taken the lead.

Under the name of "Black Opal," a stone appeared a few years ago in the market, and, like anything new was eagerly sought after, and attained a high commercial value. Certainly the colours are very lovely in these specimens, yet how they acquire their blackness and deep tints is questionable. Some other hand than unassisted Nature may have been at work. A few pure black or blue-black Opals have, however, been cut from the natural matrix, sent from Queensland. One black Opal, the size of a hen's egg, was sold in Paris for £1,000. These stones are still rare.

Opal.

Composition ...	Silica, with 10 to 12 per cent. water.
Specific Gravity	2 to 2·2.
Hardness	5·5 to 6.
Form	Amorphous.

CHAPTER XI.

THE TURQUOISE.

UNDER the name of *Callais* or *Callaina*, Pliny describes a greenish gem-stone, which has generally been regarded as our modern Turquoise. This identification, it is true, is open to some doubt, but it is, nevertheless, the custom of many mineralogists, to designate the Turquoise in scientific language by the name of *Callaite*. In popular phraseology, however, the beautiful stone is invariably called Turquoise.

"It hath its name *Turcicus*" (or Turquoise), says Baccius, "either because of its excellent beauty, or because it is brought from the Turks."

Thomas Nicols, in his "Lapidary," says, "The Turquoise is a hard gem, of no transparency, yet full of beauty: its colour is sky-blue, out of a green, in which may be imagined a little milkish infusion. A clear sky, free from all clouds, will most excellently discover the beauty of a true Turquoise." This gem is throughout of the same beauty, as well internally as externally ; it requires no help of tincture or foil to set it off in grace, the constancy of its own beauty being its support. Its exquisite colour, which loses nothing by candle-light, is no doubt owing to the

presence of a certain quantity of phosphate of copper. Those specimens of the Oriental Turquoise which retain their colour perpetually, are said to belong to the "Old Rock;" and are very scarce; while those that lose their colour, or become green by exposure, are ascribed to the "New Rock."

The Turquoise does not occur crystallised, but is found only in a compact form, having no cleavage, but possessing a conchoidal fracture. It is infusible before the blow-pipe, but is readily affected by acids. Chemically, it is a phosphate of alumina, in a hydrated condition; and its composition has been investigated with great care by Professor A. H. Church.

It is doubtful whether the true Turquoise was known to the Ancients; but in the Middle Ages it was well known and most highly valued, and few stones had such wonderful gifts and virtues attributed to them as this had. Yet to realise these advantages it was a necessary condition that the stone should have been received as a gift. Even to this day, in Russia, there is a proverb, "That a Turquoise given by a loving hand carries with it happiness and good fortune;" and another, "That the colour of a Turquoise pales when the well-being of the giver is in danger."

The Shah of Persia has long been credited with the possession of the finest Turquoises in existence, for Nishapur, in Khorassan, the locality from whence the most precious of these stones is obtained, is within his dominions; and it is said the best Turquoise was invariably picked out and retained by him, whilst the poorer specimens only were permitted to go into the market.

The Orientals cut texts from the Koran on Turquoise and fill in the characters with gold. There are some very good specimens of engraved mineral Turquoise, but

they are neither very ancient nor many in number. Nicols speaks of one possessed by the Duke of Etruria, which was the size of a hazel-nut, and had the image of Julius Cæsar engraved on it. There are two in the collection of the Duke of Orleans, on one of which is engraved an image of Diana, and on the other that of the Empress Faustina. A jeweller in Moscow at one time possessed a Turquoise two inches long, cut in the shape of a heart, and said to have belonged previously to Shah Nadir, who wore it as an amulet. A verse from the Koran is inscribed upon it in gold, and £780 was the price asked for it. The late Sir Richard F. Burton, in his book on "The Gold Mines of Midian," makes mention of a very fine Turquoise which he saw set in the stock of a Bedouin matchlock, and notched across to resemble a screw. Though exposed to wear and tear for some fifty years, it had lost none of its colour.

There was sold in the year 1808 a mgnificent necklace of Turquoise consisting of twelve stones, of a beautiful pale blue, each stone engraved in relief with a figure of one of the twelve Cæsars. A remarkable cameo in Turquoise, representing the head of Tiberius, exists in Florence. There is also a fine cameo Turquoise in the South Kensington Museum.

According to old writers, the Turquoise was found in the remote parts of India, and was conveyed to Turkey to be cut. It is, however, by no means clear that the true Turquoise has ever been found in India. Mr. Prinsep, from the appearance of certain copper ores from Rajauri in Ajmir, suggested the possibility of Turquoise being found there; and subsequently it was reported to be found in the Ajmir hills and at Ramgah, in the Shekhwati country; but this was probably only a variety of copper ore.

Discoveries in the land of Midian have shewn that three Turquoise mines exist there; the northernmost, at Aynuneh already worked, the southernmost, near Ziba (still scratched by the Arabs), and the central one not known precisely save to the Bedouins, who call it Jebel Shekayk. But all the stones from these localities soon lose their colour.

The Arabian Turquoise, though no longer worked, was highly prized by the ancient Egyptians, who opened Turquoise-mines in the Wady Maghara, in the Desert of Sinai, as far back as the period of the Great Pyramids. The Turquoise occurs there either in nodules scattered through a base of red marl, or in veins running through red sandstone. The mines have been visited and described by Mr. H. Bauerman.

The late Major MacDonald sent to the Exhibition of 1851 some fine Turquoises which he had obtained from the sandstone quarries in the Desert of Arabia. Egyptian Turquoises, however, are of only small value, because their colour usually fades when exposed to the light. So it happened with those exhibited in 1851. One of them, bought at a high price, had so faded within a year as to be almost worthless.

It is known that Turquoise was extensively worked by the ancient Mexicans previously to the discovery of America, and it is probable that this was at least one of the stones known under the name of *Chalchihuitl*, and noticed by Bernal Diaz, Torquinado, and others. The Spaniards found that this "green stone" was highly esteemed for personal ornaments and for the temples of the gods; and indeed it was relatively more valuable than gold; an earring of it being deemed a fair exchange for a mule.

Of late years attention has been directed to the ancient

workings for Turquoise at Los Cerillos, about 24 miles south-west of Santa Fé, in New Mexico. It is there found in little veins or nuggets, covered on the exterior with a white tufaceous crust; but stones of much commercial value are comparatively rare, though lately some fine stones have come to hand. Many tons of the rock may be crushed without producing a single specimen.

Some of the Mexican Turquoises are of a fine blue colour, but most inclines to green, and, in some specimens, the green colour predominates. The chemical composition of the mineral from Los Cerillos has been made the subject of careful investigation by Professor F. W. Clarke, the chemist to the Geological Survey of the United States.

The old excavations at Los Cerillos are of enormous extent, pits having been dug in the solid rock to a depth of 200 feet. About two centuries ago a sudden inundation broke in upon the unfortunate Indians who were working in the subterranean galleries, and killed about one hundred of the workmen. So great was the destruction generally that the enterprise was abandoned. A few years ago an attempt was made to renew the work by a Company, but it was not found remunerative, and at present the work is only carried on in rough fashion, on a small scale, principally by the Indians; the Turquoise is cut into rough ornaments and sold by the natives at a cheap rate in Santa Fé, and along the line of railway. By the ancient Mexicans it was a favourite material for inlaid mosaic work, of which some beautiful examples are preserved in the Christy collection in the British Museum.

Turquoise of green colour is also found in Cochise County, Arizona, at a locality known as Turquoise Mountain, which was worked on a considerable scale by the ancients. The mineral is likewise known to occur in

Mineral Park, Arizona; and at a few localities in Nevada and California.

Turquoise has also been recently discovered in Victoria, and is worked in a mine called "New Discovery."

THE PERSIAN TURQUOISE MINES.

The famous Turquoise mines of Khorassan in Persia were described officially in 1884, in a Report drawn up for the British Legation at Teheran by General Houtum Schindler, who had held office as Director of the Mines, and Governor of the Mining District. The Shah had granted a concession of the mines for fifteen years to the Mukhbur-ed-Dowleh, who associated himself with several partners. Gen. Schindler, after managing the mines for about a year, found so many difficulties in working under this Company that he left in May, 1883, having been there rather more than a year. For much of the following information we are indebted to his Report.

The Turquoise mines are situated in the Bâr-i-Madèn, a district of the Nishâpûr province, about 40 miles north-east of Sabzvâr, and 32 miles north-west of Nishâpûr, in the north-eastern part of Persia, under latitude 36° 28′ N., longitude 58° 20′ E. The mountains of the district consist of nummulitic limestone and sandstones, resting on clay-slates, and enclosing great beds of gypsum and rock-salt. On the north of the Madèn valley, the stratified rocks are broken through by porphyries and greenstones, and are consequently much metamorphosed. The Turquoise-bearing ridge, which rises to a height of 6,655 feet, consists of these eruptive and metamorphosed rocks. The Turquoises form veins in the altered strata.

The inhabitants of the Madèn-village are entirely occupied with the mining, cutting and selling of Turquoises.

The gain has made the people careless of anything else, yet there are very few of the inhabitants who possess much. A good Turquoise is found, and the money obtained by its sale is spent at once; one can often see at the mines, men who yearly pay 60 tomans* to the Government, and who gain quite 150 tomans besides, having nothing to eat.

The Turquoise mines are of two kinds: (*a*), the mines proper, with shafts and galleries in the rocks; and (*b*), the Khâkî mines or diggings in the detritus of disintegrated rocks washed down towards the plain.

(*a*). The mines proper. The most easterly, and according to all accounts the oldest mine is the *Abdurrezzâgî* which was formerly called the Abû Ishâgî, and is with that name mentioned in old books. Its mouth is at the absolute height of 5,900 feet; it is a very extensive mine, and has a depth of 160 feet vertical from its mouth. For the last few years, very few Turquoises have been obtained from this mine, but its Turquoises are esteemed more than those of other mines. Close to this mine, and in the same valley, are the *Surkh*, *Shâperdâr* and *Aghâlî* mines, which are at present neglected.

A little to the west of the Abdurrezzâgi valley, is the "*Derreh-i-Safîd*," the White Valley, with the old mines *Mâlekî*, the upper and lower *Zâkî*, and the *Mîrzâ Ahmedî*. The former three are immense mines, but almost entirely filled up.

The Turquoises of the "*White valley*" though very good, are not so fine as those of the *Abdurrezzâgî*. Many Turquoises, generally small, are found in the rubbish of the old mines; and are much prized for their colour.

In the lower *Zâkî*, now a vertical shaft of 60 feet in

* The value of the *toman* was, in 1884, 6*s*. 8*d*.

TURQUOISE in the Matrix.

depth, and about 250 feet in circumference, it may be plainly seen how the mines have got to their present ruined state. Vertical shafts were formerly cut into the rock for lighting and ventilating the mine, while the entrance of the mine was by lateral galleries driven in on the slopes of the mountains. Schindler thinks it very probable that the mines were, as late as the first quarter of the last century, worked by the Government. When the Sefâvîeh dynasty came to an end, the mines were neglected, and left to the people of the village, or perhaps, as now, farmed to them. The farmers thought only of getting a quick return for their money, and cut away the rock wherever they saw any Turquoises, exactly as they do at the present day. As a result, the supporting pillars and the rock between the different shafts were cut away, and the roof, so to say, of the old mine, fell down, filling it up. The three above-mentioned mines have been filled up in a similar manner.

The mouth of the *Mîrza Ahmedî* mine, which was probably once a part of the Zâkî mines, lies about 80 feet lower than that of the Zâkî mine, and goes down about 80 feet vertical. It also has very good Turquoises, but working in it is very precarious on account of the bad state of the galleries, and the amount of loose rubbish they contain.

The next valley is the *Derreh-i-Dar-i-Kûh.* In it are several important mines, the *Kerbleâi Kerîmî*, the *Dar-i-Kûh*, and others. The *Dar-i-Kûh* mine is very deep, going down about 150 feet vertical. It is an old and very extensive mine, and some of its galleries continue as far as *Zâkî* mine; it is very dangerous on account of the rubbish it contains; the rubbish is badly propped up by stones and small sticks, and several labourers have at times been

buried in it. All the mines in the *Dar-i-Kûh* valley are worked, and contain good Turquoises.

Further west is the "*Derreh-i-Sïyah*," the Black Valley, with the old *Ali Mirzâï*, (a contraction of Ali Murtezâ), and the *Reîsh* mines.

The *Ali Mirzâï*, particularly the lower one of that name, is very dangerous. The rock which is soft and much disintegrated, often falls and fills up the mine. A part of this mine is called the "*Bi-râh-rô*," the shaft "without a road:" to go down into it is very difficult. The Turquoises of the *Ali Mirzâï* are not good, as their colour soon fades.

A little to the south of the *Ali Mirzâï* mine lies the *Khurûj* mine, very extensive, but partly filled up; it had some sixty years ago, very good Turquoises, and is at present not worked.

On the top of the *Reîsh* mine, in the same valley, a vein of Turquoises was discovered a few years ago, and a new mine was opened there with the name of "*Sar-i-Reish*" (the head of the Reîsh). In it are found Turquoises of fine colour and great size, but the colour soon fades and the Turquoise becomes a dirty green with white and grey spots. As long as these Turquoises are kept damp they preserve their colour, but if once they get dry they are worth very little. A Turquoise as large as a walnut and of a fine colour was found in this mine in 1882, and was presented to the Shah; but, after it had been two days with His Majesty, it became green and whitish, and was found to be worth nothing

The next valley called the "*Derreh-i-Sabz*," the green valley, contains the old Ardelânî and Sabz mines, and the new Anjiri mines. The *Ardelânï* was once a very great mine; more than twelve old shafts, now filled up, are still

to be seen; its present entrance is by a large artificial cave with a dome-like roof; it has a vertical depth of 85 feet, and is very badly ventilated, having several galleries with foul air. Such galleries are called "chirâgh-kush," *i.e.*, lamp extinguishers. The Ardelânî Turquoises are not good. A "Jowâher nâmeh" (Book on Jewels) written during the seventeenth century, mentions that the Turquoises of the most inferior quality were obtained from the Ardelânî.

The *Sabz* mine has, as its name implies, green Turquoises, and is at present filled up.

The *Anjîrî* mines, which have their name from some fig trees growing in the valley (Anjîr = fig), are new mines. They produced during the last few years a very great quantity of Turquoises, which had a fine colour, and sold well. The colour, however, soon faded, and the possessors of these Turquoises are now far from satisfied with their purchases. These stones were sent to Europe and kept moist in earthenware pots till they were sold; but when removed from the damp they lost colour, and in a year or two became quite white.

The next and last, also the most westerly valley, is the one with the *Kemerî* mine. This mine, which is full of water, has some thick veins of Turquoises, but the stones are of no use for rings, being generally worked into amulets, brooches, seals, &c.

There are many more mines with names, perhaps a hundred, and more than a hundred nameless ones, but they are either parts of those enumerated above, or they are unimportant. Work in these mines is carried on by means of picks, and crowbars, and gunpowder. Blasting with gunpowder has come into vogue only within the last thirty years; formerly all the work was done by picks, and

having been frozen in the ice. This fossil Turquoise derives its blue colour from the phosphate of iron, or *Vivianite*, with which it is impregnated. It is easily distinguished from the mineral or true Turquoise, by emitting an odour when gently heated. It is, also, softer and more opaque than true Turquoise. It differs entirely from the mineral in composition and original structure and it rarely, if ever, loses its colour. The bony structure may be detected under the microscope. Abroad the fossil Turquoise is more esteemed than in England, in consequence of its freedom from outward change, but it is not so valuable as the Rock Turquoise.

The other mineral often mistaken for Turquoise is *Callainite*—a substance which far more closely resembles the true gem than does the Odontolite. It is, however, of a lighter colour, and has not the peculiar optical properties of the Turquoise. The Turquoise has a translucency peculiarly its own, reflecting light from under its surface; it also easily receives a brilliant polish. The Callainite, on the contrary, is a duller stone, not so vivid nor so fine in colour.

Beads and other ornamental objects in a greenish mineral much resembling Turquoise have occasionally been unearthed from the ancient sepulchral monuments with which the land of Brittany abounds. About twenty five years ago M. Damour, the eminent French chemist, analysed some specimens from near Lockmariaker, in the Morbihan, and finding them to be a phosphate of alumina, of green colour, identified them with Pliny's *Callais*, and suggested a revival of the old name. Dana afterwards proposed for this substance the modified Plinian name *Callainite*, but more recent researches have proved its identity with the mineral called by Breithaupt *Variscite*.

True Turquoise.

Chemical Composition—

Phosphorus pentoxide ...	32·8.
Alumina	40·2.
Water	19·2.
Copper oxide	5·3.
Iron and manganese oxides	2·5.
	100·0.

Hardness	6.
Specific Gravity	2·75.
Form	Amorphous

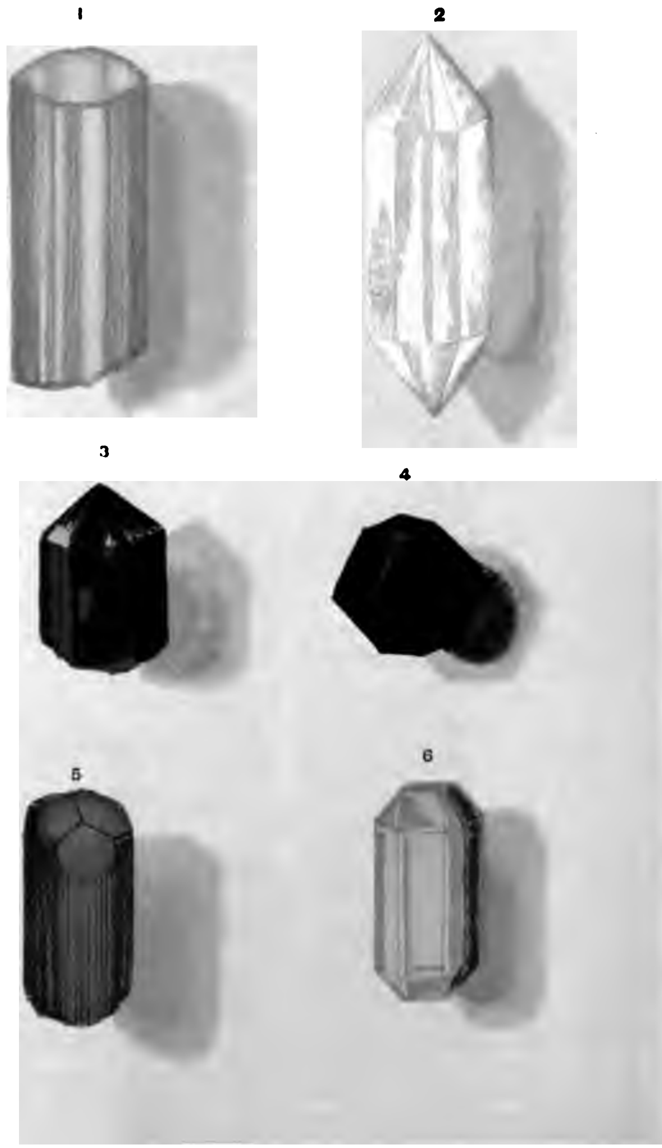
SECTION IV.

PRECIOUS AND SEMI-PRECIOUS STONES,

Of less commercial value than those described in the foregoing pages.

It is deemed advisable to arrange this large series of Stones in alphabetical order, without expressing any opinion as to their relative values.

The coloured plate opposite represents several of these stones, shewing their crystalline form, which it is hoped may serve as a guide to those who are interested in the study of gems.



1. Crystal of Aquamarine.
2. Crystal of Quartz.
3. Crystal of Amethyst.
4. Crystal of Garnet.
5. Crystal of Tourmaline.
6. Crystal of Peridot.

CHAPTER I.

THE AGATE.

BY the term Agate, the mineralogist understands a composite substance, an association of certain siliceous or quartz-like minerals, which in texture, in colour, and in transparency are diverse one from another. These Agate-forming minerals are chiefly Chalcedony, Carnelian, Jasper, Quartz, and Amethyst. Two or more of these, forming a variegated stone, and usually presenting a diversity of spots and stripes, may be denominated an *Agate.* The name is derived from the river Achates, in Sicily, now known as the Drillo, in the Val de Noto, wherein, according to Theophrastus, the ancient Agates were found, in his time.

The Agate is occasionally found in veins, as in certain localities in Saxony and Bohemia, but, as a rule, it occurs in the form of nodules embedded in an amygdaloidal rock, more or less akin to basalt.

On the decomposition of the amygdaloidal agate-bearing rock, the enclosed Agates, by reason of their resistance to the disintegrating effects of weather, remain

behind as nodules; hence Agates are frequently found loose in the beds of rivers.

Various theories have been propounded from time to time, for the purpose of explaining the origin of the Agate nodules in the cavities of the rocks wherein they occur. The cavities themselves have unquestionably resulted from the imprisonment of gas bubbles, whilst the rock was in a molten condition. The agate-bearing rock is, in most cases, an ancient lava. The nodules of Agate are considered to result from the crystallization, or non-crystalline deposition, of silica, from a solution with which the cavity of the nodule or geode became filled. The silica—now in one condition, such as Jasper, now in another, such as Chalcedony, and then again in the crystallized form of Quartz—was deposited over the irregular inner surface, giving rise to those concentric markings which are seen on the sections of most Agates. This deposition of silica would continue until the geode became filled so as to form a solid Agate, or the inlets of infiltration became stopped up, or the supply of siliceous solution failed. In other cases the silica would be deposited around the cavity in concentric layers, while, after a time, owing to some change in the natural conditions, the silica might be deposited in layers on the floor of the cavity, in obedience to gravitation, and the various coloured bands would then run parallel to each other in horizontal layers.

According to certain fancied similitudes, which the Agate stone displays to things in common use, it receives a distinguishing name. Thus *Riband Agate* exhibits strata or layers of different colours which play one into the other. If the stripes of varied hues converge towards the centre, it receives the name of *Circular Agate;* and if in this centre there are other coloured points, it is called *Eye Agate.*

When the variously coloured bands are disposed in an angular pattern, suggestive of the plan of a polygonal fortress, it is called *Fortification Agate.* In *Rainbow Agate* the stripes form a bow, presenting the colours of the Iris when the stone is held towards the sun or a strong light; the thinner the stone the more this peculiarity is noticeable.

In speaking of *Oriental* and *Occidental Agate*, we conventionally understand that all the most beautiful and translucent sorts belong to the Oriental, and the less valuable to the western variety.

Although very fine Agates are found in India, our chief supply is derived from South America. In the bed of the Rio Pardo, the Taquarie, and other rivers in Uruguay, Agate nodules are found in considerable quantity and often of large size. These are generally known as "Brazilian Agate," and are largely exported to the polishing mills of Germany. These mills are situated mainly in the neighbourhood of Oberstein, on the Nahe, a tributary to the Rhine at Bingen. The location of the Agate industry in this district was originally determined by the occurrence of Agates in the melaphyre rocks of the Galgenberg, where they were worked more than four centuries ago. The quarries, or rather mines—for the Agate rock was worked in subterranean tunnels by aid of artificial light—have been abandoned since the discovery of the Agate in Uruguay; but the work of cutting and polishing the stone is still carried on largely in the neighbouring villages.

In a district of 8¾ square miles, stand the two little towns of Oberstein and Idar, the chief centres of the Agate industry. Not only is a great proportion of the inhabitants of these towns in some way occupied in cutting,

polishing, and colouring these stones, but for miles round, every valley is dotted with the homes of those who follow this business.

In 1770 there were only twenty-six cutting and polishing mills in Birkenfield, whereas in 1870 there were 180, half of which were built within the twenty years preceding. In each mill there are four or five grindstones. These stones are of red sandstone, which is obtained from Zweibrücken ; two men ordinarily work together at the same stone. The Agate is usually cleaved to the requisite form by means of the hammer, a work which exacts much skill from the artisan : for he must be well acquainted with the natural grain of the Agate, since there is no true cleavage to guide him.

One of the most interesting branches of the Agate industry is that of colouring the stones by artificial means. This subject has already been dealt with in the chapter on "The Dyeing of Precious Stones," p. 36.

In the amygdaloidal rocks of Perthshire, Forfarshire, and other parts of Scotland, Agates of very pleasing patterns are found. These are cut and polished under the name of "Scotch Pebbles," and are employed as ornamental stones in common jewelry.

Agate.

Chemical Composition	Silica.
Hardness	7.
Specific Gravity	2·6.
Form	Amorphous, and nodular.

CHAPTER II.

AMAZONITE.

A BEAUTIFUL green mineral is occasionally used as an ornamental stone under the name of *Amazonite* or *Amazon Stone.* Until lately it was nearly all derived from Siberia, but in recent years magnificent examples have been found at Pike's Peak, Colorado; while it has also been discovered in Scotland.

Amazon-stone is a bluish-green felspar, formerly regarded as a variety of orthoclase, but placed by M. Descloizeaux, on account of its optical behaviour, with *microcline.* Its colour has been referred to the presence of oxide of copper, but according to Mr. König, it is due to an organic compound of iron.

Amazonite.

Composition—	Silica	65.
	Alumina	18.
	Potash	13.
	Soda, &c.	4.
		100.

Hardness	6·0.
Specific Gravity	2·5.
Crystalline System	Triclinic.
Form	Various prismatic combinations

CHAPTER III.

AMBER.

AMBER is a fossil resin, and its external condition, as well as its chemical composition, points to its vegetable origin. This view is strengthened by its frequent occurrence in connection with brown coal or lignite.

If further proof were wanting of the vegetable origin of Amber, it exists in the inclusion of insects, leaves, pieces of wood, moss, seed, and little stones, all of which may be seen in that which is found on the coast of the Baltic. The condition of these inclusions proves the liquid character of the resinous matter as it flowed forth and involved the insects; and it shews, also, the subsequent slow process of the solidification which ensued. The most delicate parts of the creature are often preserved in their natural positions —probably because the Amber, when it originally exuded from the tree, was a liquid of thin consistency.

The innumerable organic remains, which this resin has preserved uninjured for thousands of years, gives us a marvellous insight into the vegetable life of that division of the Tertiary period known to geologists as the Miocene age—the age to which the amber forests of northern

Europe may be referred. We here see plants quite unknown at the present day in the flora of the northern sea-coasts, but which have a relationship to the existing flora of the shores of the Mediterranean. The late Professor Goeppert, of Breslau, christened the principal Amber-yielding tree the *Pinites succinifer.*

Amber is non-crystalline, translucent, and somewhat brittle; it has a specific gravity as nearly as possible the same as that of sea-water. Its fundamental colour is yellow in all shades, running on one side into white and hyacinth-red, and on the other into brown and black. The green and blue specimens are never pure.

It becomes electrical by friction, and this property was familiar to the Greeks as far back as the days of Thales of Miletus, who observed that when rubbed it acquired the property of attracting light substances. The word Electricity is, in fact, derived from the Greek word *electron*, signifying *Amber.*

Amber is soluble in sulphuric acid. Chemically, it is composed of a volatile oil, several resins, and succinic acid. The principal resin of Amber is known to mineralogists as *Succinite*—a name sometimes applied to Amber itself.

Wherever Amber is found, whether in France, Holland, Greenland, Sweden, Italy, Sicily, Spain, Siberia, China or India, it is in association with brown-coal or lignite. The most prolific fields of Amber are the great plains of northern Germany, and the coasts of the Baltic, especially between Königsberg and Memel, where it occurs in a loose clayey sandstone, which, from its colour, is known as "blue earth." At Palmicken, in Samland, in eastern Prussia, the Amber is systematically worked by subterranean mining; but in most places the Amber gatherers simply dig it from

the soil, or pick it from the cliffs, or collect the nodules that are cast by the waves upon the shore.

Specimens of Amber, in the form of rolled nodules, are occasionally found washed ashore in this country, especially on the coast of Norfolk, near Cromer.

Large quantities of Prussian Amber are sent to Breslau, Odessa, and Constantinople. Amber forms a very important industry not only in Dantzic, Königsberg, Stolpe, and Lübeck, but in Vienna, Constantinople, and Catania, in Sicily. It is notable that the Sicilian Amber possesses a peculiar opalescence, or even *fluorescence*—presenting a difference of tint according as it is viewed by transmitted or by reflected light.

In Stolpe alone the value of the Amber industry amounts yearly to about £10,000. In Paris the most exquisite wares are made of Amber, and command extraordinarily high prices. Necklaces and bracelets of Amber are sent to Egypt and India, and the meanest Turk seeks a piece of it for his pipe, not only because it is pleasant to the lip, but because he has a belief that it will preserve him from inhaling pestilence.

Amber was much valued by the Ancients, particularly by the Romans. From the second Imperial epoch down to the middle of the fourteenth century, Amber was cut into knives and one-pronged forks, which the princes and great church dignitaries used for cutting up various kinds of fruits and vegetables, especially their esculent fungoids—mushrooms, and the like. It was at one period far more valuable than gold. The Greeks very early received from the Phœnicians chains made of Amber, both for the neck and arms, and it is mentioned in connection with heathen mythology from very ancient times.

According to the legend, the sisters of Phaeton,

mourning and weeping at his unhappy end, attracted the pity of the gods, who mercifully changed them into trees, and their tears still flowing on, became Amber. A yet stranger origin is given to this fossil, in the well-known couplet of the fire worshippers—"Around thee shall glisten the loveliest Amber, that ever the sorrowing sea bird hath wept." The great value set upon Amber even in prehistoric times in this country is seen in the care with which objects of this material were interred with their possessors in tumuli or burial-mounds of very early date. The finest specimen in this country is an Amber cup in the Brighton Museum, originally found with bronze and stone weapons in a barrow at Hove.

Amber is found in several localities in the United States, mostly in New Jersey and in Massachusetts; but it rarely occurs of sufficient beauty or in sufficient quantity to be available for ornamental purposes. It occurs with lignite in Alaska; and is abundant in certain parts of Mexico.

Amber.

Composition ...	Carbon, Hydrogen, and Oxygen
Specific Gravity	... ... 1·08.
Hardness ...	... ... 2.5.
Form ...	... Amorphous; occurring as nodules

CHAPTER IV.

AMETHYST.

THIS term is now applied to all the violet and purple crystals of Quartz, which, when fractured, present the peculiar rippled or undulated structure described by Sir David Brewster. The stone called *Oriental Amethyst*, is strictly a variety of Sapphire, of violet colour, but the term is applied commercially to any Amethyst of exceptional beauty.

Amethyst is a variety of Quartz containing traces of oxide of manganese, to which the violet colour of the stone is attributed. When heated, it becomes white and opalescent. The crystals, like those of quartz in any other of its manifold varieties, are of sufficient hardness to scratch glass, and are infusible before the blow-pipe.

The Amethyst is *dichroic*, or exhibits under certain conditions two distinct tints—the one being reddish purple and the other bluish purple.

Amethysts are usually found in association with Agates. Brazil, Uruguay, and Siberia furnish us with the best specimens of the dark coloured stones. The common Amethyst is found in nearly all parts of the world.

The Amethyst is not now of so much value as formerly. To show the fall in the value of this stone, we may refer to the Amethyst necklace of Queen Charlotte. It consisted

of well-matched and very perfect stones, although only of the common variety, and was valued at £2,000; it is doubtful whether, apart from its historical associations, it would now realise £100.

Intaglios of very ancient date, and in every style are met with in Amethysts. As a rule, stones of a pale colour are used for engraving rather than the dark; yet the late Rev. C. W. King says he has seen perhaps the grandest Greek portrait in existence, a head of Mithridates, cut in a large Amethyst of the deepest violet colour, which was found a century ago in India. There was another very ancient intaglio of the head of Pan in the Uzielli collection. One of the largest Amethyst cameos was the gem, representing a bust of Trajan, taken from the Prussian treasury during the Napoleonic wars.

It may be added that the word "Amethyst," though probably of Oriental origin, is usually regarded as derived from the Greek privative *a* and the verb *methuo*, "to intoxicate"—whence the old notion that this stone was an antidote to drink, a charm against intoxication. Tradition has even gone so far as to assert that wine drunk from a cup of Amethyst is incapable of producing inebriation!

Amethyst.

Composition:—

Silica, coloured by oxide of manganese.

Specific Gravity	2·6.
Hardness	7.
System of Crystallization	Hexagonal.
Form of Crystals	Generally six-sided pyramids and prisms

CHAPTER V.

ANDALUSITE.

THIS mineral, which was named from its occurrence in the province of Andalusia, in Spain, is occasionally found in Brazil in clear crystals, admitting of being cut as an ornamental stone. It is remarkable for displaying marked pleochroism. Some of the green crystals shew in the dichroiscope green and yellow images, whilst the brown crystals give a reddish brown and a greenish yellow. A remarkably fine specimen of rich colour and great brilliancy, weighing 17½ carats, was recently in the author's possession. Although a beautiful stone its hardness is only slightly above that of quartz.

Andalusite.

Chemical Composition :—

Silica	36·9.
Alumina	63·1
	100·0.

Specific Gravity	3·1.
Hardness	7 to 7·5,
Crystalline System	Orthorhombic.
Form	Prismatic Crystals.

CHAPTER VI.

AQUAMARINE, OR BERYL.

AQUAMARINE is a name given to those varieties of Beryl which possess a pale green colour suggestive of sea-water, whence the name *aqua marina*. In fact, the Beryl, the Aquamarine, and the Emerald are all united by mineralogists under the head of a single species, inasmuch as they are found to agree in crystallographic and chemical characters while they differ mainly in colour. The pale green of the Aquamarine is probably due to the presence of a small proportion of oxide of iron, whereas the rich green of the Emerald appears referable to oxide of chromium.

The Aquamarine is not a stone of great hardness, and consequently it tends to lose polish and suffer abrasion; this softness naturally detracting from its value in the jeweller's estimation.

Most of the Aquamarine comes to us from Brazil, already cut; but the stones are also found elsewhere, viz., in the granite regions of the Ural Mountains, and of the Altai Mountains, in Siberia. Formerly they were obtained from the frontiers of China.

Fine examples of the varieties known as *Beryl* are

obtained in Siberia, in the granite district of Nertschinsk. They occur at times as prismatic crystals of twelve inches or more in length. At Daüria, in the mountains of Odon Tchelon, there exist at different elevations, in a mass of decomposed granite, crystals of Beryl of a green tint, varying towards a warm yellow, rarely exceeding an inch in length. At a higher range there is a vein of micaceous clay, containing crystals of purer green and of greater size. At the summit the gem is of a different hue, remarkably transparent, and presenting the blue tint of some valuable Sapphires. In France, Bavaria, Saxony, and Bohemia, the Beryl is also found. In some parts of the United States it occurs in coarse crystals of a very large size. The Beryl is also found in New South Wales.

This gem is a great favourite with the English, chiefly because it possesses the advantage of retaining its lustre in artificial light. Jewellers distinguish the varieties of this stone in a manner peculiar to themselves, viz.: the green and blue varieties they call Aquamarine, while the yellow variety receives the name of Beryl. But the former is again sub-divided into (1) *Aquamarine*, pure, light sky-blue ; (2) *Siberian Aquamarine*, light greenish-blue, bright lustre, and faintly coloured ; (3) *Aquamarine Chrysolite*, greenish-yellow, or sometimes yellowish-green, with bright lustre.

One of the finest specimens of Aquamarine is the remarkable sword-hilt which was in the collection of Mr. Beresford Hope, exhibited for some years in the South Kensington Museum. It is beautiful in colour and perfectly pure. It is covered with facets, and is unique both as a mineral and as an example of the lapidary's art. This magnificent stone, which is said to have belonged to Prince Murat, weighs 3½ ozs.

In the same collection was an Aquamarine engraved to represent a female holding a bagpipe; a light drapery floating around the upper part of the body.

Aquamarine is made into a variety of ornaments. It is said that the Emperor Commodus possessed an Aquamarine engraved with a portrait of Hercules by Hyllus; and that in the treasures of Odescalchi there was a stone engraved by Quintilius, representing Neptune, drawn by sea-horses. In the National Library in Paris there is a beautiful engraving by Evodus, on Aquamarine, of the head of Julia, the daughter of Titus. An Aquamarine, $2\frac{1}{16}$ inches long and $2\frac{3}{8}$ in thickness, adorned the tiara of Pope Julius II.

Aquamarine.

Composition—	Silica	66·8
	Alumina	19·1
	Glucina	14·1
		100·0
Specific Gravity		2·7
Hardness		7·5
System of Crystallization		Hexagonal.
Forms of Crystals		Six-sided prisms.

CHAPTER VII.

AVANTURINE.

IT is related that a French glass maker, happening to let some brass filings fall into his glass-pot, was surprised to find that the product presented a beautifully-spangled appearance. To this gold-spotted glass the name of *Avanturine* was given, because it had thus been formed *par aventure*—"by accident." The name was afterwards applied to a mineral which presents an appearance somewhat like that of the avanturine glass.

This mineral, though rare, is nothing more than a translucent variety of Quartz, generally of brownish-red but sometimes of green colour, and having disseminated throughout its mass a vast number of glittering points which appear generally to be minute scales of Mica. It is found principally in Siberia, and is used to a limited extent as an ornamental stone.

Avanturine.

Composition—Silica, with oxide of iron, alumina, and other impurities.

Specific Gravity	2·6.
Hardness	7.
Form	Massive and schistose.

CHAPTER VIII.

BLOODSTONE.

BLOODSTONE, or *Heliotrope*, is a variety of Jasper, of a deep green colour, interspersed with red spots, which resemble small drops of blood, whence its name.

Heliotrope, or Bloodstone, although a beautiful material, is not much used for ornamental purposes, except for signet rings. Being a rather hard stone, and yet not difficult of manipulation, it is a favourite with engravers, and hence crests and monograms are frequently engraved upon it. Cups and other ornamental objects of small size, are also fashioned from it. It was much prized by the ancient Egyptians and Babylonians, who employed it for seals and intaglios.

In the Royal Collection in Paris is a bust of Jesus Christ in this mineral, so executed that the red spots of the stone stand out like real drops of blood.

Bloodstone.

Composition—Silica, with a small percentage of peroxide of iron,

Specific Gravity	2·6.
Hardness	7.
Form	Amorphous.

CHAPTER IX.

CARNELIAN.

CARNELIAN is nothing more than a pale-red variety of *Chalcedony*, itself a form of Quartz, characterized by its translucency, or semi-opacity, and by an entire absence of crystalline texture. The word *Carnelian* is said to be derived from the Latin word *Caro*, "flesh," in allusion to the reddish colour of the stone. As to the word *Chalcedony*, some believe it to be derived from *Chalcedon*, now Kadi-Kene, an ancient city in Bithynia, the place where it was earliest found. The Ancients called the Carnelian or some similar stone *Sarda*, either from the town of Sardis in Asia Minor, or from the Arabian word "Sard" (*yellow*). Luther translates the Hebrew word "Odem" or "Adam" (*red*) (Exodus, chap. xxii. v. 17), by Sarda.

Carnelian is chiefly found in nodular masses, and in the interior of Agates, Its colour varies from blood-red to wax-yellow, and reddish-brown; it is cloudy, seldom striated, semi-transparent, and of waxy lustre. By heat the colour of Carnelian becomes intensified, because its colouring matter, which is a hydrated oxide of iron, or ferric hydrate, becomes dehydrated, or loses more or less of its water, and is thus reduced partially or completely to the state of anhydrous oxide of iron, or ferric oxide, the colour of which is bright red. By an over application of

heat it sometimes loses its colour and becomes white, pale, and friable. It is found with amethyst and chalcedony at Oberstein in the province of Birkenfield, and in sandstone at Waldshut in Baden. It occurs in extraordinary beauty as pebbles, in agate-gravels near Ratanpur, in the state of Rajpipla, in the East Indies. In the same manner it is found in the rivers of Uruguay.

The jewellers and lapidaries distinguish the different kinds of Carnelian by the following names—1st, Masculine, or Carnelian of old stone, dark red; 2nd, Feminine, pale red, passing into yellow; 3rd, Sard, brown, passing into pomeranian and yellow; 4th, Sardonyx, where layers of the Sard alternate with layers of white; 5th, Carnelian Onyx, blood-red stripes playing into white; 6th Carnelian Beryl, a whitish yellow variety.

Carnelian is used for rings, seals, watch keys, beads, and other objects of adornment. It is very much employed for Cameos, and for engraving. Certain Carnelians from India are most *bizarre* in their appearance. The natives cover the whole stone with carbonate of sodium, and subject it for a moment to intense heat, so that a hard molten mass is produced, in which they cut designs.

Carnelian of a ruby colour is of more value than the other varieties of chalcedony; the pale-red ranks next. At Oberstein and Idar ordinary pale-grey chalcedony is coloured red by chemical means, and thus converted into a brightly tinted Carnelian. Since this industry has been introduced, the value of Carnelian has much diminished; and probably the market has not been improved by the very large importation of Brazilian stones.

This stone appears to have been chosen by the Greeks and Romans for cameos in consequence of its possessing a beautiful colour and a certain hardness, affording a facility

for manipulation. The oldest Greek gems known are in the collection of the Emperor of Germany. One of them is a Carnelian, on which is represented a winged Jupiter appearing to Semele; and the other an opaque Sardonyx, on which is engraved a draped figure of Venus. They are more modern, however, than the butterfly of the first epoch of the Etruscan art of engraving.

There is a Carnelian of the earliest period in the St. Petersburg collection, on which a man's head is engraved, with most artistically arranged beard.

The British Museum possesses an example of the second period, viz., a Carnelian butterfly, carrying a representation of Venus, of very fine workmanship. The dress of the goddess hangs in rich and graceful folds.

A Carnelian of the third period is in the Royal Collection of Vienna, and represents Helena. On a small Carnelian, in the Collection at Florence, there is a head of Apollo, adorned with laurels and fillets. In the Berlin Museum there is an unique Indian Carnelian, almost as transparent as the Hyacinth, engraved with the head of Sextus Pompeius. One of the most famous of the ancient deep-cut stones represents the birthday festival of Dionysius, and was once in the possession of Michael Angelo.

Carnelian.

Composition—Silica with oxide of iron.

Specific Gravity	2·6.
Hardness	7·
Form	Amorphous

CHAPTER X.

CHRYSOBERYL.

THE ORIENTAL CHRYSOLITE OF LAPIDARIES

THERE is probably no stone the composition of which has been given with so much variation as this. There is, however, reason to believe that chemists have frequently analysed different stones, and confounded them under one term. The true Chrysoberyl, as known to us to-day, is essentially a compound of alumina and glucina, with varying proportions of oxide of iron. There are three varieties of this stone—the *Chrysoberyl*, the *Cymophane* or *true Oriental Cat's Eye*, and the *Alexandrite*. The colours of the Chrysoberyl range from light asparagus green, golden yellow, brownish yellow, and golden brown, to columbine red.

The crystalline forms of the Chrysoberyl belong to the rhombic system. It is usually found as rolled pebbles in the same sands as those which furnish crystals of Topaz and Corundum. Twin-crystals of two kinds and of great beauty are found in the Emerald mines of Takowaja, east of the Catherine Mountains in the Ural. It is brittle, transparent, or translucent, and possesses in a high degree the power of double refraction, and a vitreous and oily lustre. A peculiar bluish opalesence, in the inner part of the stone, is sometimes seen.

It is interesting to trace the history of our knowledge of the chemical constitution of this mineral. Klaproth and Arfwedson considered it to be composed of silicic acid and alumina. To Seybert we are indebted for the discovery of glucina in Chrysoberyl. He conceived it to be composed of silicic acid, alumina, and an aluminate of glucinum or beryllium. Thomson declared he could find no silicic acid in it, and was confirmed in this view by Rose.

Asparagus or yellow-green Chrysoberyl was known in very early times to the people of Ceylon and Brazil. In Ceylon it is found in river sands in company with Tourmaline, Spinel, and Sapphire. In Borneo, and in Burma, it is found amongst pebbles and loose alluvia. In Brazil, pieces of the Chrysoberyl of the size of a hazel nut, and of yellowish-green colour, are sometimes met with while washing for Diamonds. Of late years it has also been found in granite in Connecticut, North America, in well-formed tables and prisms, with Tourmaline, Garnet, and Beryl; and at Saratoga and Greenfield in New York State, in regular twin crystals with Tourmaline, Garnet, and Apatite.

Chrysoberyl.

Composition—Alumina	...	78
Glucina	...	18
Ferrous oxide	...	4
		100

Specific Gravity ... ... 3·5 to 3·8

Hardness ... ... 8·5

Crystalline System Trimetric or ortho-rhombic.

Form Flat prisms; generally as rolled pebbles.

CHAPTER XI

CHRYSOPRASE.

THERE can be no question that the Chrysoprase of the Ancients was a very different stone from that which is known by this name at the present day. Pliny speaks of it as a well-known gem, and tells us that vessels were made of it, and that the stone was obtained from India in great quantities. No antique works in true Chrysoprase have come down to us, and it is probable that the Chrysoprase of modern mineralogists was unknown to the Greeks and Romans. Our true Chrysoprase is a green variety of Chalcedony, of extremely local occurrence.

It has been said that Chrysoprase was first discovered by a Prussian officer, near a mill on the Kosemütz Mountains in 1740. It is quite certain however, that Chrysoprase had been known and used for some centuries, although its true home had not been actually ascertained until a comparatively recent date. The costly mosaic walls of St. Wenzel's Chapel, in the Cathedral of St. Beit at Prague, built in the 14th century, contain splendid specimens of Chrysoprase.

Chrysoprase is found in Silesia, near Kosemütz, Gläsendorf, and Baumgarten, not far from Frankenstein.

It occurs in veins of serpentine, in company with other siliceous minerals, such as Quartz, Chalcedony, and Opal.

Among the semi-Precious Stones, the Chrysoprase deserves to be one of the greatest favourites. It possesses a beautiful apple-green colour of many shades, and a transparency and capability of high polish, together with the advantage of being found in large pieces. Yet in this country the Chrysoprase is not a fashionable stone. One of its peculiarites is, that by constant use, such as sealing, it partly loses its colour and gradually becomes paler. Heat and sunshine affect the colour by the action on its oolouring constituent, the oxide of nickel. It was the great chemist, Klaproth, who discovered the presence of nickel, and that the stone contained a small quantity of water. The nickel oxide is therefore, probably united with water, as hydrate, in the Chrysoprase, and if by the influence of heat, some of the water in the stone is lost, the beauty of the colour is more or less destroyed. The Chrysoprase is chiefly used for signet rings, buckles, and pins. As a rule, it receives the table-cut or *cabochon* form.

At Oberstein a green colour is imparted to ordinary Chalcedony, by means of salts or nickel or of chromic acid so as to produce an artficially tinted Chrysoprase.

Chrysoprase.

Composition—	Silica	97·5
	Oxide of Nickel, &c. ...	2·5
		100·0
Specific Gravity	... ...	2·6
Hardness	... ...	7
Form	... ...	Amorphous.

CHAPTER XII.

CROCIDOLITE.

WITHIN the last few years a great deal of this mineral has been brought from South Africa, and introduced into commerce as *Cat's Eye;* but as previously explained, the true Oriental Cat's Eye is a valuable and beautiful gem; while this is comparatively worthless. It is, in fact, mainly a ferruginous Quartz, associated with a fibrous mineral known as true Crocidolite, or a pseudo-morph after it.

Crocidolite is a mineral belonging to the group of Hornblendès, and consists of thin delicate silken fibres compacted together in masses, and often associated with Magnetite or magnetic-oxide of iron. Specimens from the Orange River sometimes contain enough Magnetite to be employed as "natural magnets."

When Crocidolite is cut *en cabochon*, it exhibits, in some degree, the Cat's Eye effect; it being an optical property of all acicular or fibrous minerals, when cut with a curved surface, to show more or less chatoyancy on a line at right angles to the fibres of the substance.

The colours of the Crocidolite are usually some shade of yellow, with a ray of a lighter colour; or rich brown

deepening to almost black ; or a dark indigo with a ray of lighter blue. The brown variety is known as *Tiger's Eye* and the blue as *Hawk's Eye.*

The so-called Crocidolite Cat's Eye comes principally from a locality on the Orange River in Griqualand West, but is also found in other parts of South Africa. It has been regarded as mainly a pseudo-morph of quartz or chalcedony after true Crocidolite—in other words, the original material has been converted into a quartzose substance while retaining its fibrous form. It seems, however, that some of the so-called Crocidolite used as an ornamental stone is a mixture of Crocidolite and Chalcedony, with much oxide of iron. The mineral has been studied microscopically and chemically by Fischer, Wibel and Renard and Klement.

Crocidolite.

Chemical Composition :—

Silica	51
Oxide of iron	34
Soda	7
Magnesia	3
Water	5
	100.

Specimens vary very much in composition, and some of the South African mineral is mainly chalcedony.

Specific Gravity ... About 3.
Hardness ... ... Nearly 7.
Form ... ... Fibrous masses in veins

CHAPTER XIII.

EUCLASE.

THIS mineral has occasionally been cut and polished as a gem-stone, but rather as a matter of scientific curiosity than with a view to its introduction into jewelry. It is, in fact, a very rare mineral, occasionally found with Topaz at Villa Rica, in Brazil. It is also known to occur with Beryl on the river Sanarka, in the Urals.

Euclase is always found in crystals which exhibit perfect cleavage, and perhaps the most curious feature of the stone is its excessive brittleness—whence, indeed, the name " Euclase," from *eu* and *klao*. Its colour is generally a pale straw, passing in some specimens into blue and green. The mineral is trichroic, and possesses considerable lustre. In its chemical relations it stands closely related to the Emerald.

Euclase.

Chemical Composition :—

Silica	41·20
Alumina	35·22
Glucina	17·39
Water	6·19
	100·00

Specific Gravity	3
Hardness	7·5
Crystalline Form	Trimetric.
Form	Prismatic crystals

CHAPTER XIV.

THE GARNET, CARBUNCLE, AND CINNAMON STONE.

UNDER the general name of Garnet, the mineralogist includes a number of stones which present a great variety of colour, ranging from the lightest cinnamon, through all shades of red and crimson, and even to various tints of green. Between these diverse minerals the chief bonds of association are to be found in their crystallographic relations, and their constancy of chemical type. On glancing at the various analyses of different Garnets, one might fail to recognize their relationship ; but the chemist is aware that these changes of composition take place according to certain definite laws, without violating the general type on which they are constructed. Their specific gravity, and even their hardness, are subject to great variations, corresponding to their differences of composition. They all belong to the isometric or cubic system, and are consequently monochroic.

The Garnet, or Carbuncle, was a great favourite with the Ancients, and antique Garnets have often been found in Roman ruins. In former days it was very frequently engraved, and beautiful specimens are now to be seen in Paris, Turin, Rome, and St. Petersburg. The small degree of hardness possessed by this stone renders engraving on it comparatively easy.

The word Garnet probably owes its origin to the similarity of the colour of this stone to that of the blossom and kernel of the pomegranate, a fruit of Southern Europe. It is not a name of ancient date. Pliny calls it "Carbunculus," from *Carbo*, "a live coal." According to some authorities, however, it is thought that the origin of the word Garnet is to be found in *granum*, "a grain," because it is so often found in granular forms. The Precious Garnet is sometimes called "Almandine," from the city of Alabanda, in Caria, Its colour is blood-red, cherry-red, or brownish-red : by candle-light it assumes a violet tint.

Garnet is so widely distributed, that only a few of the most important localities can here be mentioned. In the mountains below the river Enns, in Austria, large transparent crystals are found in serpentine. In the Zillerthal, crystals of an inch in length are found embedded in chlorite slate. These are taken to Bohemia, and worked into ornaments. The Garnets found in Bohemia are generally reduced to powder for polishing purposes.

In Norway, it is found in granular masses, some specimens being of rare beauty. In Sweden, fine large crystals are found embedded in mica-schist.

Switzerland is rich in Garnet. On the St. Gothard, well-developed crystals of deep-red colour are found in mica-schist. In the Rheinwald, large bright-red crystals occur in gneiss ; and in the Simplon Pass they are found in the glacier streams, of small size, but very beautiful. They occur in great abundance, also in gneiss, near to Almeria, in Spain,

In Hindostan, Garnet is abundant in the neighbourhood of Ragavapurum, in the Kistna district ; and in Ceylon it occurs everywhere in gneiss, particularly at Trincomalee and at Adam's Peak.

In Greenland, Garnets not unfrequently fall out of the matrix, which is a chlorite-slate, and leave a regular impression behind. In the United States they occur in granite, hornblende-schist, and gneiss. New Mexico, Arizona, and Colorado yield fine varieties, which are cut as gem-stones. Fine crystals occur, embedded in mica-schist, in Alaska. In Brazil, Garnets occur in a variety of localities, sometimes in talc slate, and in river-beds in company with Diamonds.

In Australia very fine crystals are found near the Ovens, in Victoria; and at numerous localities in New South Wales. Fine Garnets have been found abundantly in the MacDonnel Ranges in the interior of South Australia, and have been sometimes termed "Australian Rubies."

A new variety of Garnet, closely resembling the Burmese Ruby in colour, was found a few years ago under very difficult circumstances, in the interior of New Mexico. Lapidaries were at first unable to determine, by mere cutting, the nature of this stone. No Garnet had ever been seen in Europe possessing a colour so closely approaching that of the Ruby. A specimen was accordingly sent to Professor Crookes, F.R.S., who, by careful analysis, found that it contained as much as 42 per cent. of Alumina.

The principal varieties recognized by mineralogists are the *Almandine*, or Precious Garnet; the *Essonite*, or "Jacinth" and "Hyacinth;" the *Pyrope*, or Bohemian blood-red Garnet, and the *Uwarowite*, or green Garnet. Each of these will now be separately described.

Almandine (Carbuncle).

The Almandine is a beautiful stone of a rich claret colour, and is the most esteemed of the whole family of

Garnets. It is the stone which is generally employed for Carbuncles.

The Carbuncle is simply an Almandine cut "*en cabochon*"—that is, with a convex surface, which is polished all over without facets, the upper part being of various degrees of convexity. The under side is manipulated so as to secure the desired shade. Sometimes it is left flat, sometimes faceted, and frequently hollowed out, so as to improve the colour; and it has been customary, from long before the time of Pliny, to foil it with either silver or gold. Pliny included a great variety of red stones under the general term *Carbunculus.* Carbuncles of late years have gone out of fashion. At one time a good Carbuncle of the size of half-a-crown has been known to realize as much as £50.

Almandine Garnet is occasionally found to be asteriated with a six-rayed star, but such specimens are rare.

Almandine (*Carbuncle*).

Chemical Composition :—

Silica	36·5
Alumina	21·0
Iron oxides	34·5
Magnesia	4·0
Lime	3·0
Manganese oxide	1·0
	100·0

Specific Gravity ... ...3·5 to 4.3

Hardness ... ... about 7

Crystalline System ... ... Cubic.

Forms ... Rhombic dodecahedron and 24-faced trapezohedron.

Pyrope.

The Pyrope, sometimes known as "Bohemian Garnet," is of a blood-red colour, never purple. When cut like a brilliant it is very bright, but owing to its occurring in small pieces, it is more usually rose-cut and mounted *en pavé*. It is found principally in Saxony and Bohemia, where it occurs embedded in Serpentine. By the gradual decomposition of this matrix, the Garnets are set free and being carried down by streams, are found in the sands of the rivers, where they are collected by children. Fine Pyropes occur with the Diamonds of South Africa, and are sometimes termed "African Rubies."

Pyrope.

Chemical Composition :—

Silica	41·5
Alumina	22·0
Magnesia	15·0
Iron protoxide	9·5
Lime	5·0
Chromium sesquioxide ...	4·5
Manganese protoxide ...	2·5
	100·0

Specific Gravity	3·7 to 3·8
Hardness	7·5
Crystalline System	...Cubic.
Forms	Same as those of Almandine.

Essonite.

This stone passes under three names according to its colour. The lightest of the three is of a pale cinnamon colour, and is hence known as *Cinnamon Stone.* The next is a little darker, with a peculiar admixture of red and orange, and is known to jewellers as *Jacinth.* The last has a darker shade of bright red, orange, and brown, giving rise to the peculiar hyacinthine tint, and it is therefore called in trade a *Hyacinth.* It is a common error to confound these hyacinthine Garnets with Zircons of the same colour, to which the names Jacinth and Hyacinth are sometimes applied.

Essonite comes principally from Ceylon, where it is found in large pieces. It is cut thin on account of depth of colour, with a pavilion-cut below and a broad table above, bordered with small facets.

At Dissentis, in Switzerland, beautiful crystals are found, of a reddish-yellow colour, in a variety of Quartz, formerly called "Hyacinth of Dissentis;" and equally fine specimens with diopside, occur in Piedmont and at St. Gothard. From the dolomite region of Mexico we obtain Cinnamon stone of a beautiful red colour, resembling Spinel. Essonite is also found, finely crystallized at Phippsburg and Warren, in New Hampshire, and at Raymond, in Maine, U.S.A.

A Garnet resembling Essonite in composition, but of green colour, is known as *Grossularia,* or "Gooseberry Stone." It is found chiefly in Siberia.

Essonite.

Chemical Composition—

Silica	40
Alumina	23
Lime	32
Oxide of Iron	5
	100

Specific Gravity	3·4 to 3·7
Hardness	7
System	Cubic.
Forms ...	Same as those of Almandine.

Uwarowite.

Of the many other varieties of Garnet, more or less rare, occurring in a state of perfection fit for jewelry purposes, mention need be made of one only, namely, the *Uwarowite.* It is a green variety of very limited occurrence, and found in specimens of only small size It presents a fine Emerald-green colour, and when sufficiently clear and large forms a beautiful and lasting stone; its hardness being greater than that of any other Garnet. It is very little used in jewelry, and is often confounded with the "green-Garnet" of the Urals, which is a much softer stone, but one which nevertheless exhibits a good amount of "fire," especially by artificial light, and has a much greater range of colour than the Uwarowite. This latter stone has only been known within the last few years; it is a silicate of iron and lime, but its right to a place among the true Garnets has been questioned. It is found in the

gold-washings of the Bobrowska, a stream which flows into the river Tschussowaja, in the Ural Mountains. By mineralogists it has been termed *Demantoid*, and by Russian jewellers it is often called "Siberian Chrysolite,"

Uwarowite.

Chemical Composition:—

Silica	37
Lime	33
Chromium oxide	23
Alumina	7
	100

Hardness	7·5 to 8
Specific Gravity	3·5
Crystalline System	Isometric or Cubic.
Forms	Rhombic dodecahedra and 24-faced trapezohedra.

CHAPTER XV

HEMATITE.

THERE are certain ores of iron which are used to a limited extent in jewelry and in the Fine Arts—notably *Hematite*, a mineral which has been used from time immemorial for intaglios, and latterly for the imitation of black Pearls. Although of steel grey colour when polished, the streak of the mineral, when scratched, is of a reddish-brown or cherry-red colour, whence the word *Hematite*, meaning " blood-stone," is derived.

The occurence of Hematite is wide-spread, but the hard variety which is polished as an ornamental stone, is found chiefly in the Carboniferous Limestone of Cumberland, especially near Whitehaven. Crystals, when found, have often a highly splendant lustre, and are hence known as " Specular Iron-ore." Usually, however, the Hematite occurs in reniform or kidney-shaped masses, whence it is often called " kidney-ore."

Hematite.

Composition—Peroxide of Iron, containing—

Iron	70
Oxygen...	30
	100

Specific Gravity	4·5 to 5·3
Hardness	5·5 to 6·5
System	Rhombohedral.

Form—Complex modifications of Rhombohedra; but generally reniform and massive.

CHAPTER XVI.

HIDDENITE.

THE Hiddenite is a comparatively little known gem-stone, having been discovered only a few years ago in Alexandra County, North Carolina, by Mr. W. E. Hidden, after whom it was named. In appearance it is something like the Emerald, both in its rough and cut states. Being a novelty, there has been a demand for it in America, a stone of only 2½ carats realising £25. It is of a brilliant green hue, verging towards yellow, and possesses a beauty of its own. Hiddenite is a variety of the mineral called *Spodumene* or *Triphane*, and is sometimes termed "Lithia Emerald."

Hiddenite.

Composition—A silicate of Aluminium and Lithium.

Specific Gravity	3
Hardness	7
Crystalline System	Monoclinic.

CHAPTER XVII.

IOLITE.

UNDER the name of *Iolite* or *Dichroite* the mineralogist is familiar with a certain stone which is remarkable for its pleochroism, or difference of tint when viewed in different directions. Occasionally it is cut and polished as a gem-stone, and is known to the jeweller as *Saphir d'eau.* The best specimens come from Ceylon, those from Bavaria being almost opaque. It is also found at Haddam, Connecticut. The usual colours are various shades of blue and violet, whence the name "Iolite."

Iolite.

Chemical Composition :—

Silica	49
Alumina	34
Magnesia	9
Ferrous oxide	8
	100.

System of Crystallization	Trimetric
Specific Gravity	2·6
Hardness	7
Form	Prismatic crystals, or as pebbles.

CHAPTER XVIII.

JADE.

TRUE Jade is known to mineralogists as *Nephrite*, or "kidney-stone," in consequence of its former use in diseases of that organ. It is a compact variety of hornblende, consisting of a silicate of magnesium and calcium. Much of the Jade has been separated from Nephrite as a distinct species under the name of *Jadeite.* This is a silicate of aluminium and sodium, and seems to be a form of acmite. The specific gravity of Jadeite is as high as 3·3, while that of true Jade never exceeds 3·18.

The Chinese have for ages worked this stone into most elaborate and delicate forms, and prized it as one of the choicest products of the mineral kingdom. It was also used by the Maories, or natives of New Zealand, chiefly for the grotesque breast ornament known as the *tiki*, and for the peculiar club called the *mere*, or *pattoo-pattoo.* This bright green Jade, called in New Zealand *punamu*, or "green stone," has lately been used in this country for earrings, pendants, and other ornamental objects. It is also found in New Caledonia, Turkestan, Burma, and a few other localities, in limited quantity.

Jade.

Chemical Composition (Green Jade of New Zealand):—

Silica	57·75
Magnesia	19·86
Lime	14·89
Oxide of iron, alumina, &c. ...	7·50
	100·00

Specific Gravity	2·91 to 3·18
Hardness	6·5
Form ...	Amorphous ; occurring as a rock.

CHAPTER XIX.

JASPER.

BY modern mineralogists the term Jasper is restricted to the opaque varieties of Quartz, which present a compact texture, and are destitute of any crystalline structure. But the Jasper of the Ancients was evidently a different substance, inasmuch as it is usually described as possessing a green colour associated with more or less translucency. The Greek name, *Jaspis*, according to Isodore, "signifieth green, and such a green as doth illustriously shine forth with a very supreme viridity, or greenness of glory." Pliny considers the *Jaspis* to be a gem of a dull-green colour, like an Emerald, but not so transparent. The name itself is very ancient. This gem is the *Jaspeh* or eleventh stone, in the breastplate of the High Priest. The glory of the Jasper is often made use of in the Holy Scriptures to represent the New Jerusalem.

Pliny assures us that Eastern nations wore pieces of it as amulets. Even Galen soberly asserts that "the green Jasper benefits the chest and mouth if tied upon it;" and De Boot, writing so late as 1609, does not hesitate to ascribe rare medicinal virtues to the Jasper. Nicols, who wrote in the middle of the 17th century, says, in his quaint

way, " Divers do very superstitiously attribute much power and virtue to the cross-white Jaspers, if figures and characters be engraven upon them."

The Red Jasper was much valued in early times for engraving. In the Vatican there is a beautiful vase of Red Jasper, with white veins, and another of Black Jasper, with yellow veins. In China the Emperor's seal is of Jasper ; and in that country the stone is highly valued. In Florence the Yellow Jasper is largely employed for Mosaics, and the Riband Jasper for cameos.

Thomas Nicols writes : " This gem or stone of price for its fulness of glory, and excellence of beauty, cannot admit of any foyl or tincture to commend its beauty withal; and further, it is ascribed, by way of glory, to the King of Egypt, that the first adulteration of the Jasper by tincture was from him: but the glory of this praise, if I be not mistaken, doth even become his shame."

Jasper is commonly found in compact masses of kidney shape, or as pebbles. Its colours are green, yellow-brown, and red of various shades, rarely blue. That known as *Egyptian Jasper* is found in round or spheroidal masses, in the desert near Cairo ; it is of dull red colour, or ochre-yellow, deepening into chestnut-brown. Very frequently these colours form stripes or zones in the stone, which are probably the result of decomposition of the upper surface. An Egyptian Jasper in the Mineralogical Collection of the British Museum (now at South Kensington) is remarkable for displaying on its fractured surface a very good likeness of the poet Chaucer, produced accidentally by the natural marking of the stone.

Red Jasper is found abundant near Mühleim, in Breslau, in the iron ore of that district, and in numerous other localities.

Common Jasper, generally red and brown, but sometimes yellow and black, is found in many localities; for example, in the old rocks of North Wales and in Scotland.

Riband or Striped Jasper occurs in compact masses with a conchoidal fracture. It has stripes or zones of grey, green, yellow, red, and brown, and is mostly found in Siberia; but is also obtained in smaller quantities in Sicily, Corsica, the Hartz, and Tyrol.

The so called *Porcelain Jasper* is only burnt clay.

Jasper.

Chemical Composition:—

Silica	99·5
Oxide of Iron	·5
	100·0

Specific Gravity	2·6
Hardness	7
Form	Amorphous.

CHAPTER XX.

LABRADOR.

THE Spaniards found amongst the ornaments of the Indians, dwelling upon the shores of the Amazon, grotesque figures formed of this mineral, supposed to have been exhumed from the tombs of the old Peruvians. It is now found principally on the northern coast of Labrador, and was originally sent home by the Moravian missionaries.

From its occurrence in the Peninsula of Labrador, where it forms, by its remarkable brilliancy of colour, the "fire rocks" of the Indians, it is variously known as *Labrador*, *Labradorite*, or *Labrador felspar*. The last name shows that it belongs to the great family of Felspars. It is, indeed, a common constituent of many rocks, but only exceptional specimens are sufficiently beautiful to be used as ornamental stones.

Generally speaking, the body-colour is a dull grey, brown, or greenish brown; but typical specimens of the mineral possess a remarkable iridescent chatoyancy, or internal reflection of prismatic hues, especially bright blue and green, with more or less golden yellow, peach colour, and red. From its remarkable play of colour it has become a great favourite with many connoisseurs, and is much used for cameos. The colours are best seen when the stone is polished flat, parallel to the reflecting surfaces.

In addition to the brilliant iridescence, many specimens of Labrador exhibit a peculiar spangled appearance,

like that of Avanturine. The iridescence is due to the presence of numberless thin plates, which give rise to what are called "interference phenomena," whereby a peculiar brilliancy is obtained, something like that on a peacock's feather. The spangled effect is attributable to very minute plates of oxide of iron distributed through the stone. It is not, however, every piece of Labrador that exhibits these phenomena. The stones which have the most beautiful colours come from the coast of Labrador and St. Paul's Island, where they occur in masses, and from Norway, where they are found as loose blocks.

Great care has to be taken in the manipulation of this stone to preserve the play of colour; for if any facets are given to it, this generally disappears. Large and beautiful specimens of this stone are much valued. The first block of Labrador was brought to Europe in 1775, and the rock was discovered in Russia in 1781. Still later, two blocks were found on the shores of the Paulkovla, which exceeded all hitherto known specimens in size, one weighing 1,000 lbs.

Labrador.

Composition :—Silicate of aluminium, calcium, and sodium.

Silica	52·9.
Alumina	29·3.
Lime	12·3.
Soda, etc.	5·5.
	100·0.

Specific Gravity	2·7.
Hardness	6.
Crystalline System	Triclinic.
Form	Usually in cleavable masses.

CHAPTER XXI.

LAPIS-LAZULI.

THIS stone is remarkable for its beautiful blue colour, whence the Arabians call it *Azul*, meaning "blue." It is, without doubt, the Sapphire of the Ancients—a blue stone which Theophrastus describes as "spotted with gold dust," while Pliny speaks of it as being "like to the serene blue heavens, fretted with golden fire." The "gold" mentioned by these and other ancient authors refers to the spangles of brass-like iron-pyrites which are commonly dispersed through the rich blue substance of the Lapis-Lazuli.

The colour of the stone varies from pale azure to deep blue, with a tint of green; but is seldom quite pure, being often mottled with white and yellow spots. Indeed, the Lapis-Lazuli is not a homogeneous substance, but consists of a definite blue mineral, which is probably referable to the species *Haüyne*, associated with a colourless substance, whence its mottled appearance. It is brittle, has but little lustre, and is translucent only at the corners or thin edges.

The precise origin of the beautiful blue colour of the Lapis-Lazuli is still a matter on which chemical opinion is divided. It is usually referred to the presence of a sulphide, probably of sodium and iron, but it appears likely that the sulphur is present in the form both of a sulphide and of a sulphate. Lapis-Lazuli fuses with great difficulty,

and expands before the blow-pipe, after which it becomes a porous, colourless glass; but if heated with saltpetre, it turns to a beautiful green. According to Field, the variety of this stone, which comes from the Cordilleras, loses its blue colour by heat, but regains it on cooling. The colour is discharged by the action of strong acids.

In the Cordilleras, near the sources of the Cazadero and Vias—little tributaries of the Rio Grande—not far from the high road leading to the Argentine Republic, and a short distance from the great watershed in the Chili dominions, the Lapis-Lazuli is found in a thick stratum of carbonate of lime, accompanied by small quantities of iron pyrites. This deposit rests upon slate, and is covered by another stratum consisting of rich iron-ore, which contains a large amount of Garnet. Over this last lies the granite, constituting the summit of these mountains.

Lapis-Lazuli is also found in Siberia, on the shore of the Shudank, particularly on the lands near the Baikal Lake, into which that river empties itself. Marco Polo, in his travels to the princes of Tartary in 1271, found it in the upper district of the Oxus, mixed with iron ore, whence the Armenian merchants still bring it to the market of Orenburg, in Eastern Russia. In many provinces of China, and in Bucharia, it is found in granular limestone with iron pyrites, and, on the banks of the Indus, in a greyish limestone.

The Lapis-Lazuli was used in classical times for cameos and intaglios, of which a number remain to this day. The Chinese have for a long period, worked it into vases, caskets, buttons, cups, and the like, and have also used it for porcelain painting. There is a prejudice against Lapis-Lazuli, as it loses polish by constant wear and becomes dull. The stone is, however, used to a

limited extent for rings, pins, and crosses, as well as for larger objects, such as caskets, vases, candlesticks, statuettes, watch cases, and handles for sticks and umbrellas. In Italy it is a favourite stone for ornamenting churches, and in the chapel of San Martini, at Naples, the Lapis-Lazuli is profusely employed not only for decorative work, but even as a structural material. In the Zarskoe Palace, near St. Petersburg, there is an apartment, called Catherine II's. chamber, formed entirely of Lapis-Lazuli and Amber. This stone was in early times much valued, because it was the only material from which the true ultramarine of the artist, so celebrated for its effect and permanence, could be obtained. Artificial ultra-marine is now prepared on a very large scale, and closely resembles the natural pigment, not only in its splendid colour, but even in its chemical composition.

Lapis-Lazuli.

Composition :—

Silica	45·5
Alumina	31·8
Soda	9·1
Lime	3·5
Iron	0·8
Sulphuric acid	5·9
Sulphur	0·9
Chlorine	0·4
Water and loss ...	2·1
	100·0

Specific Gravity ... ... 2·3 to 2·5
Hardness ... ... 5·5
Crystalline System ... ... Isometric
Form ... Dodecahedron, but very rare ; generally massive.

CHAPTER XXI.

MALACHITE.

THERE can be little doubt that this stone was known and valued by the Ancients, yet it must have been known by some other name, and it has been suggested that our Malachite was the *Smaragdus Medicus* of Pliny. It is true that this writer speaks also of a mineral called *Molochites*, which he describes as an opaque stone, of a rich Emerald-green, and says that its name was derived from the colour of the *Malve;* that it was much used for seals, and was worn by children as a certain protection against evil. But there is reason to believe that Pliny's Molochites was probably a Jasper, and not our modern Malachite, which is a carbonate of copper, in no way related to the Jasper.

Malachite is found in almost every locality which yields copper ores, occurring principally in the upper parts of the deposits where atmospheric influences have been at work, and have converted the ore into a carbonate of copper. The largest and choicest specimens have been obtained from the mines of the Urals, and from the great deposits of copper-ore in South Australia.

Malachite is occasionally found in crystals, but perfect specimens are rare. It usually occurs in masses with

rounded surfaces—mammillated, botryoidal and reniform—which have evidently been deposited from solution in water, much in the same way that deposits of stalagmitic marble have been formed. Its gradual deposition in successive layers is shewn by the concentric structure which specimens of Malachite so often display. Owing to this structure, a slab of polished Malachite usually exhibits a beautifully variegated pattern, different shades of green being disposed in zones and bands, much like the figuring of an Agate. Its magnificent colour, pleasing pattern, and capability of polish, have led to the use of Malachite for ornamental purposes, and it is frequently inlaid with, and often used to cover, inferior stones, for vases, tables, caskets, and the like. In Russia, furniture and even doors are occasionally veneered with thin slabs of Malachite.

Malachite.

Chemical Composition—	Copper oxide ...	71·9
	Carbon dioxide ...	19·9
	Water	8·2
		100·0

Specific Gravity ... ... 3·7 to 4·0
Hardness ... ... 3·5 to 4·0
Crystalline System ... ... Monoclinic.
Form ... Usually modified oblique rhombic prisms, but rare; usually botryoidol or stalagmitic.

CHAPTER XXII.

MOONSTONE, SELENITE, AND SUNSTONE.

MINERALOGISTS of the present day apply the name *Selenite* to the finer varieties of Gypsum—a common mineral much too soft to be of any real service in jewelry, yet presenting in its fibrous forms so pleasing a lustre as to be occasionally cut and polished as an ornamental stone. This fibrous Gypsum or Selenite occurs in the New Red Marls of Derbyshire and Staffordshire, and especially in the neighbourhood of Newark, in Nottinghamshire, where it is worked to a limited extent into beads and other trivial objects. Selenite derives its name from its soft lustre, suggestive of moonshine; but though the word literally signifies "moonstone," no jeweller would think of designating it by such a term—the word "moonstone" being invaribly applied to an entirely different stone. It is clear, too, that the *Selenites* of the Ancients must have been a stone differing from our modern Selenite—which is a hydrated sulphate of calcium, so soft as to be readily scratched by the finger-nail.

"The Selenite," says Adreas Baccius, "is a kind of gem which doth contain in it the image of the moon, and

it doth represent it increasing and decreasing according to the increase and decrease of the moon, in its monthly changes." The Greeks, who called it *Aphroseline*, which signifies the splendour of the moon, or a beam of the moon, with their lively imagination, often discovered in natural objects resemblances to other forms, and ascribed to them virtues and properties according to their interpretation. The Moonstone is a good example of this. The Romans called it *Lunaris*. Dioscorides says "It is found in Arabia, and is endued with virtues, as of making trees fruitful, and of curing epilepsy;" he adds that "in the night it will illuminate the place that is next to it, yet not by any transmission of light, but by the collection of light into itself."

Marbodus describes the stone itself as growing and shrinking, and its colour as that of Jasper or Emerald. Trellus, to much the same effect, says:—"It is so named because it displays, as it were, on eye within itself, which increases or diminishes according to the growth or decline of the moon."

Whatever the Moonstone of the Ancients may have been, the Moonstone of the present day is an opalescent variety of orthoclase-felspar termed *Adularia*—a name which it derives from Mount Adula, one of the highest peaks of St. Gothard, where it occurs. The best specimens, however, come from Ceylon. There can be little doubt that the Romans received consignments of it, with the other products of Taprobane (Ceylon). The pleasing lustre of this stone, somewhat like that of Mother of Pearl has led to its use by the jeweller. It has found popular favour, too, from being reputed to bring good luck to its possessor.

A good deal of imitation Moonstone is at present in

the market, the false material being fashionable in cheap jewelry.

While one member of the Felspar group is known as Moonstone, another is recognised as *Sunstone*, This is a reddish or golden coloured variety of *Oligoclase*, exhibiting internal prismatic reflections and minute spangles due to the presence of included crystals of oxide of iron or of mica. It is found to a limited extent in Norway, and is but rarely employed in jewelry

Orpheus recognised in his day two kinds of "Gem of the Sun." "In both there appear rays shining straight and like luminous hair, but the colours of the stones are different—the one would be deemed a crystal, the other a chrysolite, except for the hair." The first of these is evidently the *Venus's hair-crystal*, which he describes.

The *Chemical Composition* of the two Felspars may be taken as follows :—

Moonstone (Orthoclase).		*Sunstone (Oligoclase).*	
Silica ...	64·7	Silica ...	61·9
Alumina	18·4	Alumina	24·1
Potash...	16·9	Lime ...	5·2
		Soda ...	8·8
	100·0		100·0

Crystalline System— Monoclinic.	*Crystalline System*— Triclinic.
Specific Gravity—2·5 to 2·6	*Specific Gravity*...2·5 to 2·7
Hardness 6	*Hardness* 6

CHAPTER XXIII.

MOROXITE.

A DARK bluish-green variety of Apatite, or calcium phosphate, found originally at Arendal in Norway, and at Pargas in Finland, has been termed by mineralogists *Moroxite.* The name is fancifully derived from a certain Greek word applied to a stone used by the Ancients in bleaching linen. Clear crystals of Moroxite have occasionally been cut and polished, but their softness renders them ill-suited for jewelry. It appears that some of the material occasionally sold as Moroxite is nothing but paste.

Moroxite.

Chemical Composition :—

Phosphoric Anhydride	41
Lime	55
Iron Oxide, Chlorine, &c. ...	4
	100

Specific Gravity	3·2
Hardness	5
Crystalline System	Hexagonal

Form ... Six-sided prisms, variously modified.

CHAPTER XXIV.

OBSIDIAN.

GEOLOGISTS are in the habit of applying this name to a volcanic glass or fused lava. At first sight it may seem strange that such a substance should find a description in a work on Precious Stones. Obsidian is, however, occasionally cut and polished, and is by no means an ineffective stone. It is generally of bottle-green colour, and when cut looks somewhat like a Peridot or a Green Tourmaline. The great objection to the stone is its softness, which is rather less than that of Felspar. A brown streaked American variety is cut and polished under the name of *Mahogany Obsidian.* A Siberian variety, with a pleasing silvery sheen, is occasionally used in the manufacture of snuff-boxes and other ornamental articles.

Obsidian.

Chemical Composition :—

Silicate of alumina, potash, iron, and lime.

Specific Gravity	2·6
Hardness	6·5
Form	Amorphous.

CHAPTER XXV.

ORIENTAL ONYX.

ONYX is a very celebrated variety of tinted Agate, having its colours arranged in parallel strata. The Oriental Onyx is obtained from India, Egypt, Arabia, and Armenia. The inferior variety mostly comes from Uruguay, Bavaria and Bohemia.

Some stone, called by translators *Onyx*, ranked among the highest class of gems in the ante-Christian world. It is often mentioned in the writings of Greek and old Hebrew authors. Pliny likens it in colour to the human finger-nail ; and it is upon this similarity that its Greek name Onyx is based.

The Greeks attached the following mythological origin to this stone : " Cupid, with the sharp point of his arrow, cut the nails of the sleeping Venus, which fell into the Indus ; but as they were of heavenly origin they sank, and became metamorphosed into Onyx."

The Onyx has been chiefly used for cameos, and very costly vessels. In making the cameo, the figure is carved out of the light colour, and stands in relief on the dark ground.

Amongst the most celebrated of these stones is the "Schaffhausen Onyx" — one of the most cherished treasures of the Canton of Schaffhausen. The figure engraved on it is a female wearing a crown of honour, holding in one hand a horn of plenty, in the other a

Mercury's staff. The figure Dr. Oeri identifies as "Pax," and the Cameo was cut between A.D. 68 and 82 It is of great historical interest and is supposed to have been brought from Constantinople by Ortlieb von Frohberg, who was a trusted friend of Konrad III and Friedrich I, and took part in the Second Crusade The later history of the gem is obscure.

One of the most famous of the Antique Cameos is the Mantuan Vase; the base is brown, and on it, in relief, are groups of white and yellow figures, representing Ceres and Triptolemus in search of Proserpine. The Vase is formed from a single stone, and is seven inches high and two-and-a-half broad. There is an Onyx Cameo in the Vatican Library, representing Octavius Augustus; and in the Emperor's Cabinet, at Vienna, there are some specimens of exquisitely cut Antique Onyx. In the Museo Nationale, at Naples, there are many specimens; among others, an Onyx Cameo (eleven inches by nine), representing the apotheosis of Augustus; and another with the head of Medusa carved on one side, and the apotheosis of Ptolemy on the other. Among the remarkable Cameos in the National Library of Paris, is one of Tiberius with an ox; a second, of Marcus Aurelius and Faustina; a third, of Agrippina with her two children; and a fourth, of Jupiter armed with lightning.

Onyx has been found in such large masses that small pillars have been made of it: there are six such in the Basilica of St. Peter, at Rome. At Cologne, in the Temple of the Three Magi, there is one broader than the palm of the hand. Appianas says that "Mithridates, King of Pontus, had 2,000 cups of this gem;" it is scarcely possible, however, to believe that they could have been of true Onyx; probably they were simply Onyx-marble.

Boetius mentions the Arabian Onyx, as "black, with white zones or circles, by reason of which many colors are caused in it. It is called an Onyx only when the black appeareth, as it were, under a white. It is a gem that hath many veines, compassed about with milky zones or girdles, and meeting in a pleasing concord and consent."

It is not at all probable that the Onyx which Professor Aaron Pick shows to be the *Shoham* of Holy Writ, was the same composite stone with that which modern writers designate by that name, for it is classed with the Ruby, Topaz, Diamond, Chrysolite, Jasper, Sapphire, and Chrysoprase. This great Hebrew scholar believes it to have been the Carbuncle.

The Onyx of ancient writers appears to have been in most cases a *banded* stone, but while it was in some instances a siliceous material, like the modern Onyx, in others it was certainly a stalagmitic variety of carbonate of lime.

By modern mineralogists the term Onyx is restricted to an Agate-like substance, formed of alternating white and brown or black layers of Chalcedony. When the white zone is so thin that the deeper dark-colored layer shines through with a bluish tint, the stone is called a *Nicolo,* an Italian corruption of "Onicolo" or "Little Onyx." If the strata be alternately white and red, or reddish-brown the resulting mixture is known as *Sardonyx.*

Oriental Onyx.

Composition—Silica, with traces of coloring matter.

Specific Gravity	2·6
Hardness	7
Form	Amorphous.

CHAPTER XXVI.

PERIDOT OR CHRYSOLITE.

THIS is a very ancient stone, at one time considered of more value than the Diamond, and worn for many centuries by ladies as an ornament.

In the Wardrobe Book of Edward I., the Peridot is mentioned among the jewels of the deceased Bishop of Bath and Wells, which were escheated to the Crown.

The Peridot has a very pleasing yellowish-green color, and is susceptible of a fine polish, but it is so soft as to be easily scratched. It is a stone that requires considerable skill and care in polishing, the final lustre being imparted to it by means of sulphuric acid. It is less dense, and less hard than stones which are generally ranked in the first class. It usually occurs in fragments much worn by the action of water, but well-defined crystals have been found which prove that its native form is that of the rhombic prism. It is remarkable that the Peridot occurs in "ærolites" or masses of meteoric stone.

Although the Peridot has not retained its pristine repute, it is still in demand, and is much valued by some of the Society of Friends. The gem looks well if judiciously set in gold, and the deeper the green the more valuable the stone.

It has been pointed out in treating of Chrysoberyl, that, owing to lapidaries calling that stone the "Oriental

Chrysolite," considerable confusion has arisen between the two gems. A comparison of their chemical composition is, however, sufficient to shew that scarcely any two minerals differ more widely in their constitution—the one being an aluminate of glucina, the other a silicate of magnesia. The Chrysolite of mineralogy is in fact, practically the same stone as the Peridot.

Mineralogists include the Chrysolite and the Peridot under the one species *Olivine.* The colors of Olivine vary from light straw yellow to yellowish green, when the stone receives the name of Chrysolite; and thence to a peculiar soft hue, of a delicate deep yellowish green, when it is called Peridot. It is found in the Levant, in Brazil, Mexico, Arizona, South Africa, and other countries, generally as small pebbles, and it occurs in fragments in most of the gold drifts of New South Wales.

Peridot or Chrysolite.

Chemical Composition:—

Silica	39·73
Magnesia	50·13
Ferrous oxide	9·19
Nickel oxide, &c.	·95
	100·00

Specific Gravity	3·35
Hardness	6·5
Crystalline System	Trimetric.
Form ...	Generally in water-worn pebbles.

CHAPTER XXVII.

PHENAKITE.

OF late years, this rare mineral has occasionally been used in Russia as a gem-stone. The kind employed for this purpose is perfectly transparent and colourless, exhibiting when skilfully cut great brilliancy, and bearing much superficial resemblance to Diamond.

Phenàkite—like the Emerald, the Chrysoberyl, and the Euclase—contains the rare metal glucinum or beryllium. The finest Phenakite occurs in mica-schist at Stretnisk, on the River Takowja, not far from Ekaterinburg, in the Urals. It is also found in the granite of Miask, in Siberia, and at Pike's Peak, in Colorado.

Phenakite.

Chemical Composition ;—

Silica	54·2
Glucina	45·8
	100·0

Crystalline System	Rhombohedral.
Specific Gravity	3
Hardness	7·5 to 8
Form	Prismatic crystals.

CHAPTER XXVIII.

QUARTZ CAT'S EYE.

FOR a description of Quartz Cat's Eye, and the True Cat's Eye, see pp. 228 to 232. Thin fibres of asbestos interspersed with regularity in the quartz give rise to the characteristic appearance of this stone. It is brought chiefly from Ceylon, and from Hof in Bavaria.

The Crocidolite, or "Wood Cat's Eye," of South Africa, known also as "Tiger's Eye" and "Hawk's Eye," has been described at pp. 281, 282.

CHAPTER XXIX.

ROCK CRYSTAL.

HEREOF the common opinion hath been, and still remaineth among us," said the learned Sir Thomas Browne, in his famous work on *Vulgar Errors*, in 1646, "that Crystal is nothing else but ice or snow concreted, and by duration of time congealed beyond liquation. Of which assertion, if prescription of time and numerosity of assertors were a sufficient demonstration, we might set down herein as an unquestionable truth; nor should their need ulterior disquisition. For few opinions there are which have found so many friends, or been so popularly received through all Professions and Ages." The word *crystal* is, in fact, a standing testimony to this strange belief, since it owes its origin to the Greek word *krystallos*, which means "ice." Pliny, Seneca, and other ancient writers—not to mention Austin, Gregory, Jerome, and several early fathers of the Church—have given their adhesion to the opinion that Rock Crystal is nothing but water congealed by a cold so intense that ordinary methods fail to melt it.

Modern science, however, dispelling such illusions, has proved that Rock Crystal is a pure and limpid form of Quartz—a natural variety of silica.

Rock Crystal is found in a variety of forms, sometimes of extraordinary size and beauty. Its colour varies from pure white to greyish-white, yellow-white, yellowish-brown, clove-brown, and black. According to its colour it receives a variety of names: thus the yellow is known as *Citrine* and *False-Topaz*, the brown as *Cairngorm* and *Smoky-Quartz*, and the black as *Morion*. The clear varieties are beautifully transparent, and possess double refraction.

The frequent admixture of chlorite, asbestos, rutile, iron pyrites, and actinolite in the crystals is very remarkable. In some specimens there are cavities with liquid enclosures, which move as the crystal is turned. These specimens are mostly from Madagascar.

The brilliant hair-brown needles of Rutile, penetrating the crystal in all directions, impart a curious appearance to the stone, and such specimens are often cut for brooches, under the name of *Flèches d'Amour*, or "Cupid's arrows," or "Venus's Hair-Stone."

Among European localities for Rock Crystal, the most remarkable are those in Switzerland. A little distance from the Grimsel, it is found in the mines of Jochle Berg and Zinkenstock. In 1735 the yield from the cave of Zinkenstock alone was valued at £2,250. The most famous mine, perhaps, is that of Fischbach, in Visperthal, which supplied the crystal for the great Pyramid of Marsfield, 1797. This block measured three feet in diameter, and weighed over 800 lbs. It is now in the Natural History Museum at Paris. The neighbourhood of Mont Blanc yields beautifully clear Crystal, which affords employment to the inhabitants of Chamouny.

The most remarkable discovery of Rock Crystal on record is that which was made in 1867 at the Galgenstock,

above the Tiefen Glacier, by a party of tourists under the guide Peter Sulzer, of Guttanen. A cave in the granite yielded more than a thousand crystals, all of large size, and weighing from 50 lbs. each to upwards of 3 cwt. They were, however, of dark colour. In the Museum at Berne there are some magnificent Crystals from this lucky discovery. One gigantic Crystal, known as the "Grandfather," weighs as much as 276 lbs.; while another, christened "The King," weighs 255 lbs.

In the clear cavities of the snow-white marble of Cararra, in Tuscany, Rock Crystal is found in great purity. Ceylon affords it abundantly; and Madagascar supplies large blocks; but it is from Brazil that our chief commercial supply is obtained, much of it being imported for the use of the optician, who cuts and polishes it in the form of spectacle lenses, which are known as "pebbles."

In this country Rock Crystal of small size is not uncommon, and has been occasionally used as an ornamental stone, under the local name of "Diamond," such as "Bristol Diamonds," "Irish Diamonds," and "Isle of Wight Diamonds."

The Greeks valued Rock Crystal for its purity and regular form. Theophrastus remarks that it was selected for seals. Pliny mentions several times in his Nat. Hist. 37. 9, that the Romans were well acquainted with its habitat in the Alps, and that they employed it largely for household luxury and adornment. They worked it into wine jugs, cups, vases, and other vessels. Nero possessed two very beautiful drinking cups, one of which cost him a sum equal to £600. When he heard of the loss of his kingdom, he is said to have broken them in anger.

The Empress Livia gave to the Capitol a piece of Crystal weighing 50 lbs.; and the Roman physicians used

Crystal balls as lenses, in order to burn out sores. Such balls were also employed for kindling sacrificial fire—the sacred Vestal flame being produced by concentrating the solar beam in the focus of a Crystal lens. Spheres of Rock Crystal were at one time carried in the hand, by the ladies of ancient Rome, for sake of their refreshing coolness—the crystal being a good conductor of heat, and thus readily robbing the hand of its caloric.

Rock Crystal is used for rings, pins, ear-rings, seals, caskets, gems, and other *bijouterie.* It is also used for Cameos, Intaglios, lenses, and spectacles. As a rule, Rock Crystal receives the form of the Brilliant, Rosette, or Table-cut; the exceptions being the Rainbow Quartz, the Hair and the Needle Stone, which are cut *en cabochon.*

It is believed that one of the finest works in Rock Crystal in existence is an urn, 9½ inches in diameter, 9 inches high, and this, together with the foot or pedestal on which it stands, is formed of one piece. On the upper part is a representation of Noah asleep, his children holding a covering, and a woman with a basket of fruit in her hand. This urn forms part of the French National jewels, and cost £4,000.

Rock Crystal.

Composition—Oxygen	... ...	53·3
Silicon	... ...	46·7
		100·0
Specific Gravity	... ...	2·65
Hardness	... ...	7
Crystalline System ...	...	Rhombohedral

Forms Various six-sided prisms terminating in pyramids.

CHAPTER XXX

SPHENE.

SPHENE is a mineral which has occasionally been cut as an ornamental stone. Its appearance is somewhat between that of Opal and Chrysolite. In colour it varies from pale yellow to green; and it exhibits all degrees of transparency, some varieties being, however, opaque. Only the most transparent and clear specimens have the least claim to be classed as gem-stones; and although it has a pleasing lustre and brilliant dispersive power, its softness is against its ever being extensively used. Among its many localities mention may be made of Arendal, in Norway, of St. Gothard and Mont Blanc, and many parts of North America.

Sphene.

Composition :—	Titanic Oxide ...	41
	Silica	31
	Lime	27
	Iron Oxide	1
		100
Specific Gravity		3·5
Hardness		5 to 5.5
Crystalline System		Monoclinic.
Form		Wedge-shaped crystals.

CHAPTER XXXI.

SPODUMENE.

IT is only of late that this mineral has been cut as a gem-stone. In colour and appearance the clear Spodumene is not unlike Chrysoberyl. Its colours vary from greyish to greenish yellow; some varieties are opaque and others transparent. It has a waxy appearance. Although susceptible of high polish, it is a very difficult material to work, partly because it is much harder in one direction than another, and partly on account of its remarkably easy cleavage, which renders it liable to split.

Spodumene is found in a large number of localities, but the transparent variety, which alone has been cut as an ornamental stone, is confined to Brazil.

The mineral previously described as ***Hiddenite***, or "Lithia Emerald," is only a variety of Spodumene.

Spodumene.

Composition—	Silica	64.5
	Alumina	29·0
	Lithia...	5·5
	Iron oxide and soda...	1·0
		100·0

Specific Gravity	3
Hardness	7
Crystalline System	Monoclinic.

Form ... Usually in fragments, exhibiting two parallel cleavage planes.

CHAPTER XXXII.

TOPAZ.

IT is believed by the highest authorities that the true Topaz was unknown to the Ancients. The name, however, is derived from the Greek *Topâzios*—a word which appears to have been applied to the Chrysolite or Peridot. This was probably the ancient classic gem, called in Hebrew *Pittdoh* by Professor Aaron Pick, and *Pitdah* by Genesius (according to the Massoreth), the latter of whom imagines that it is derived from the Sanscrit *pita* (pale), and that the Greek *Topazios* is a transposition from *Pitdoh* to *Tipdoh.* The ancient mineralogists described this as a pale yellowish or greenish gem, found in an island of the Red Sea. Boetius says it is of a "diluted green colour with yellowness added to it." Among the virtues then attributed to it we read that "the Topaz calms anacreontic temperaments." In all these cases the writers appear to have had in mind the stone known to us as Chrysolite rather than our true Topaz.

Under the general name of *Topaz* modern mineralogists include three distinct stones—(1) the *true* Topaz; (2) the Yellow Sapphire, or the *Oriental Topaz;* and (3) the *Occidental* or *False Topaz.* The second is a yellow variety of Corundum, and the third is nothing but a variety of Scotch Quartz.

The true Topaz presents a variety of colours, from clear white, when it has been occasionally palmed off as a Diamond, ranging through all shades of light blue and light green to rose pink, orange, and straw yellow. A pink colour is frequently obtained by subjecting the sherry-coloured Topazes to a moderate temperature. The instability of colour in certain Topazes is attested by the bleaching which they suffer on exposure to sunlight.

Crystals of Topaz are remarkable for their *pyro-electricity*—in other words they become electric on exposure to heat.

Tavernier, in 1665, saw a Topaz weighing 157 carats in the treasury of Aurungzeb, which that monarch had purchased for a sum corresponding to £18,000 of our money.

The Topaz mines of Brazil are near Ouro Preto, formerly known as Villa Rica. In the Ural, north of Ekaterinburg, Topaz is found in granite. In St. Petersburg is a fine crystal, 4¾ inches long and 4½ wide, weighing 31 lbs. In the east of Siberia it is found in blue crystals, in company with Beryl, Rock Crystal, and Felspar. A remarkably fine collection of Siberian Topazes, made by Prof. Kokscharow, of St. Petersburg, may be seen in the Mineralogical Gallery of the British Museum (South Kensington), where the finest crystals are carefully protected by opaque caps to shield them from sunlight, by which they might suffer loss of colour.

Topaz is found in Egypt, near the ancient Emerald Mines of Jebel Zabara. The mineral is still worked at Risk Allah.

In Saxony the white, yellow, and the pale violet crystals are found, and in Bohemia the sea-green variety. The Saxon Topazes are obtained chiefly from the well-known

Topaz-rock of the Schneckenstein. In Brazil, red specimens graduating from a pale to a deep carmine tint, have been discovered; but most of the Brazilian Topazes are of a rich wine-yellow colour. The clear and colourless Topazes of Brazil are frequently known as *Nova Minas*. The blue Topaz from Brazil resembles Aquamarine, but is distinguished by its superior hardness and higher specific gravity.

Very fine White Topaz is found in Flinders's Island, in Bass's Strait. In Australia, the Topaz is not uncommon. It is found in most parts of the New England district, New South Wales, where it occurs as pebbles in the river gravels. In the United States the chief localities for Topaz are in Arizona, New Mexico, and Colorado. Fine blue crystals have been discovered at the famous mineral locality of Pike's Peak, Colorado, and the species has also been found at Stoneham, in Maine. Topaz is said to occur, with Sapphires, in the district of Batang Padang, in the state of Perak, Malay Peninsula. It is notable that Topaz is not uncommonly found in connection with ores of tin in all parts of the world.

The Topaz is one of the few Precious Stones found in the British Isles. It occurs chiefly at St. Michael's Mount, Cornwall; in the Mourne Mountains, Co. Down; and in several Scotch districts.

In some places in India, the Topaz being rare, is a far more expensive stone than in England.

Several engraved Topazes are known: that in the Bibliothèque Royale, in Paris, is set as a signet ring, having the portraits of Philip II. and Don Carlos deeply cut in it. There is also a citron-yellow Topaz, representing an Indian Bacchus.

The antique Topaz in St. Petersburg, engraved with

the representation of Sirius, is of excellent workmanship. A celebrated Arabian Amulet composed of Topaz, having the words "From God alone is success," in Arabic, bored through it, is now the property of a Parisian jeweller.

The *Goutte d'Eau*, which is capable of exquisite polish, is a colourless Topaz. If cut as a Brilliant, with a small table, the pure gem forms a beautiful ornament; and some specimens found, both in New South Wales and in Brazil, are worthy of careful cutting, polishing, and setting.

The chemical composition of the Topaz, in addition to its obvious characteristics, confirms its title to a high rank among gems

Topaz.

Chemical Composition:—

Alumina	30·2
Silicon	15·5
Oxygen	36·8
Fluorine	17·5
	100.0

Specific Gravity	3·5
Hardness	8
Crystalline System	Rhombic.
Form ...	Prisms, terminating with pyramids; the two ends usually dissimilar; with strongly-marked basal cleavage.

CRYSTALS OF BRAZILIAN TOPAZ.

CHAPTER XXXIII.

TOURMALINE.

SOMEWHAT more than a century ago, the Dutch introduced Tourmaline into Europe, from Ceylon. The first written history of the stone is found in a book published in Leipzig, in 1707, called "*Curious Speculations of Sleepless Nights.*" It is mentioned also in the catalogue of a collection of stones sent over from Ceylon to Leyden in 1711. For many years small quantities only of this stone were sent to Europe, and the German Jews were almost its only purchasers.

Few minerals present greater complexity of chemical constitution than the Tourmaline. Its composition has been said to resemble the prescription of a mediæval doctor, in which a little of everything was thrown in ; and a reference to the analysis appended to this chapter will illustrate this intricacy of constitution. To the student of physics, the Tourmaline is a stone of singular interest, from the curious optical and electrical characters which it exhibits. It enjoys, in its different varieties, a very wide range of colour, though it rarely displays any vivid or brilliant hue ; hence it has become a great favourite with connoisseurs, who can appreciate its soft and sombre tones, but has not acquired general popularity. Its colours consist of various shades of grey, yellow, blue, pink, and brown ;

all having a tendency towards the darker hues, even to black.

The Tourmaline passes under a variety of mineralogical names, according to the colour which it presents. The red varieties are known as *Rubellite*, the blue as *Indicolite*. and the clear and colourless crystals as *Achroite*; while the common black Tourmaline is still distinguished by the old German name of *Schorl.*

It often happens that the colour is not constant throughout the stone, so that one part may be green, while another portion of the same crystal may be decidedly pink. These parti-coloured specimens come chiefly from Elba. An American variety is notable for presenting a central kernel of red colour, surrounded by a zone of lively green, and as such crystals are usually three-sided prisms, they offer, when cut across, a triangular or heart-shaped section, with the pleasing effect of a red centre fringed by a green border.

Tourmaline possesses double refraction, and polarizes light perfectly: hence it is used by opticians in the construction of polariscopes. Its dichroism is very pronounced, and may be often recognised without the aid of an instrument.

Tourmaline, in common with many other Precious Stones, developes electricity under friction. Many Tourmalines also acquire electric properties when heated—one end of the crystal becoming positive and the other negative. This phenomenon is known as *Pyro-electricity*. It is connected with the curious form of most of the crystals, their two extremities exhibiting different faces. This peculiarity of shape is termed *hemimorphism*, since half of the crystal presents one form, and half another. When the temperature of a hemimorphic crystal is either raised

or lowered, its electric equilibrium is disturbed, and polarity developed; so that the condition of the crystal may then be compared with that of a magnet.

Tourmaline is found in Siberia, Ceylon, the Urals, Saxony, and the Isle of Elba. In the United States, it has been discovered in great perfection and abundance, especially at Mount Mica, Paris, Maine.

The Siberian Tourmaline is of carmine, hyacinth, purple, or rose-red, running into violet-blue. When polished its lustre somewhat resembles that of the Ruby, and the mineral is sometimes known as "Siberian Rûby."

The Green Tourmaline generally occurs of an olive or dark green colour, and takes a perfect polish. Crystals of great beauty are found in Minas-Geraes. The Yellowish-Green Tourmaline, "Ceylon Chrysolite," is very like an Aquamarine, and is found in the river beds of Ceylon and Brazil. Colourless Tourmaline occurs very seldom in pieces worth the cost of cutting and polishing. The most beautiful specimens are found in Elba. Brown and Black Tourmaline are varieties not used for purposes of ornament. Black Tourmaline or Schorl is by no means uncommon in this country, especially in the tin-bearing districts of Cornwall.

The value of Tourmaline depends upon the colour, quality, and size of the specimens; one of exceptional colour and purity, of five carats weight, might be worth about £20.

A magnificent specimen of Rubellite, or Red Tourmaline, from Burma, is exhibited in the Mineralogical Gallery of the British Museum (South Kensington). This unique group of crystals was presented by the King of Ava to Colonel Symes when on an embassy to that country, and has been valued at £1000. It has probably lost much

of its original colour and value. The Rubellite mines of Upper Burma have been visited by Mr. Barrington Brown and by Dr. Noetling. The mineral is sent chiefly to China where it is prized for making buttons for the caps of mandarins of high rank.

The author has just received a very fine piece of reddish Tourmaline from the Cashmere Sapphire Mines.

Tourmaline.

Composition—Very complicated and varied. According to Rammelsberg, a green Brazilian stone gave—

Silica	38·55
Alumina	38·40
Boron trioxide	7·21
Ferric oxide	5·13
Ferrous oxide	2·00
Soda	2·37
Fluorine	2·09
Lithia	1·20
Lime	1·14
Manganic oxide	0·81
Magnesia	0·73
Potash	0·37
	100·0

Specific Gravity ... ... 3·0 to 3·15
Hardness ... ... 7·5
Crystalline System .. ... Rhombohedral.
Form ... ... Usually in prisms striated vertically, and differently terminated at opposite ends.

CHAPTER XXXIV.

ZIRCON, JARGON, OR HYACINTH.

THE Zircon, Jargoon, and Hyacinth are all varieties of the same stone. The term *Hyacinth* or *Jacinth* is applied to transparent and bright-coloured varieties; and *Jargoon* to crystals of dull colour, and of a smoky tinge, which have been occasionally sold as inferior Diamonds.

Anselmus Boetius gives the following description of this gem. "(1st) There are some that flame like fire or are similar in colour to crimson or to natural vermilion; these the French jewellers call 'Jacinthe la Belle,' and esteem the best. (2nd), Those with a yellow-red colour. (3rd) Others which are like unto Amber, so that they can hardly be distinguished from it but by their hardness. These are of no great value, by reason of the atoms they contain, and the multiplicity of small bodies which are in them, which do hinder their transparency and translucency." "One of these," Cardanus says, "he was wont to wear about him, for the purpose of procuring sleep, to which purpose it did seem somewhat to conduce," (4th) "There is a fourth kind which has no redness at all in it, being like white pellucid Amber, and such are of least value."

The *Lyncurion* or "Lynx-stone" of the Ancients was probably in most cases the Hyacinth, while their *Hyacinthus* may have been our Amethyst. It seems certain that when Theophrastus mentions the *Lyncurion*, he refers to an amber-coloured Zircon.

The Zircon is a lovely stone; the red and brown hyacinthine varieties being especially noteworthy. Some of the finest Jargoons present yellow, green, and blue tints, not unlike those of the Tourmaline, but with much more fire and lustre. Some specimens when submitted to great heat, increase in lustre, but at the same time lose colour.

The Zircon is distinguished when in its natural form, by its quadrilateral crystals, terminating at both ends in a pyramid. It is of adamantine lustre, transparent to sub-translucent. The fracture is conchoidal. It scratches Quartz, but is itself scratched by the Topaz.

In former times this gem was more highly valued than at present. The forms given to the Zircon are generally the Rose, the Table, and the Brilliant. Inferior Zircons require peculiar setting to shew them to advantage.

There is a splendid specimen of a very ancient engraving on a Zircon in the Paris Museum, the workmanship of which is exquisite; it is about 2 inches in length, and 1¼ in width, and represents Moses with the two tables of the law. Lord Duncannon had in his collection a Zircon with an engraving on it representing an athlete.

The finest specimen of the hyacinthine variety is a Cameo, representing the head of an angel, by Raphael, which was set in a ring and worn by Gregory XIII., and engraved with his name. At the back of the Cameo the name of Pius VII. appears.

The more brilliant specimens, which receive the name of Hyacinth, rarely attain a large size. The finest Hyacinths have been obtained from Mudgee, in New South Wales, while of other varieties Ceylon yields the best examples. The stones which often pass as Hyacinths or Jacinths, are nothing more than hyacinth-coloured Garnets, or "Cinnamon Stone"—the mineral known to mineralogists as

Essonite. The difference between the Essonite and the Zircon is immediately apparent by an appeal to the balance—the specific gravity of the former being about 3·6, while that of the latter is as high as 4·6 or 4·7.

Although the localities which yield Zircons fit for working into ornamental stones are but few, it should be borne in mind that the coarser forms of Zircon are present in a great variety of rocks, such as the Zircon-syenite of Norway and Siberia.

Nicols, writing of Zircons 230 years ago, says,—"They are found in Ethiopia, India, and Arabia. The Arabs distinguish three kinds—1, Rubri Coloris: 2, Citrini Coloris: 3, Antimonii Coloris. Of these the worst is found in the river Iser, which is upon the confines of Silesia and Bohemia. The best and most excellent ones are brought from Cananor, Calicut, and Cambia."

Klaproth in 1789 discovered in the Zircon an earthy basis, to which he gave the name of Zirconia. It is the oxide of a peculiar metal called *Zirconium*, of which the gem itself is a silicate. The word *Zircon* is of Arabic origin.

Zircon, Jargoon or Hyacinth.

Chemical Composition—	Silica ...	34
	Zirconia ...	66
		100
Specific Gravity		4 to 4·86
Hardness		7·5
Crystalline System		Tetragonal

Form Tetragonal prism with pyramidal termination: often as rolled pebbles.

APPENDIX A.

ON THE DISCRIMINATION OF PRECIOUS STONES.

THIS Appendix has been prepared with the view of aiding those readers who may wish to become acquainted with some of the scientific means employed in the critical examination of Precious Stones. As information of this kind is necessarily somewhat technical, and must be conveyed in scientific language, it has been considered desirable to add it in the shape of an Appendix rather than to incorporate it in the body of the work. This Appendix is therefore intended not so much for the general reader as for the student of Precious Stones, who is anxious to acquire familiarity with the modern methods of examining the physical properties of minerals.

SPECIFIC GRAVITY.

As specific gravity is a readily applicable, yet invaluable, aid in the discrimination of Precious Stones, a description of the usual modes of taking the specific gravity of a mineral may be useful. By specific gravity is meant the relative weights of equal bulks of different kinds of matter. Distilled water at 60 degs. F. is usually taken as the unit of comparison, so that if a gem weigh $3\frac{1}{2}$ times as much as an equal bulk of water, under the above conditions, it is said to have a specific gravity of 3·5.

One method consists in placing the gem in a liquid of known specific gravity, and observing whether it sinks or floats. The liquid must necessarily be of very high specific gravity if it is to be of any use in dealing with gems. Such a liquid as that discovered by Mr. Sonstadt, and called after him "Sonstadt's Solution," is very useful, and can be prepared of any specific gravity up to about 3. *It is, however, very poisonous, and must be used with the greatest caution.* It is prepared as follows: Take, say, about an ounce of ~~distilled water~~, and dissolve therein as much potassium iodide ~~as~~ it will take up; to which add, in small portions at a time, mercuric iodide, until no more of this body will dissolve. Again, introduce fresh portions of potassium iodide, as long as it will dissolve, and then add mercuric iodide until it ceases to disappear; and so on alternately, at the same time stirring and gently warming the solution until neither salt will further dissolve. If necessary, it may be filtered through asbestos cloth. The solution should be of a bright honey-yellow colour. It is improved by keeping a drop or two of metallic mercury at the bottom. A specific gravity as high as 3·18 may thus be attained, but for the purpose of discriminating Precious Stones, others of lower specific gravities can be employed.

In a solution of this high density, any stone in the following list would *float*:—Tourmaline, Turquoise, Emerald, Beryl, all the varieties of Quartz, and Moonstone; while Garnet, Sapphire, Ruby, Chrysoberyl, Spinel, Topaz, Diamond, and Chrysolite, from their greater specific gravity, would *sink*. The borotungstate of cadmium is a salt which gives a solution of still greater density than Sonstadt's liquid.

Another method of taking specific gravities is by weighing the stone first in air and then in water, and dividing the former weight by the difference between the two weighings. A simple method, and one generally of sufficient accuracy, is to employ a first-class pair of Diamond scales, as follows: Drill a small hole in the bottom of one of the scale pans, through which pass a double fibre of silk, so as to hang say 4 inches below the pan;

tie a knot to prevent its slipping through; suspend the stone in the silk by bending back the silk upon itself, so as to form a double slip noose; and weigh the stone very carefully while hanging suspended in this position. Then immerse the stone, as it hangs, in distilled water. It will appear to have lost weight, being, in fact, buoyed up by the water; now add carefully more weights, till an equipoise is effected; note the weight by which this is obtained, and divide the original weight of the stone by it, and the quotient will give the specific gravity required.

Example: In weighing a white stone whose specific gravity we required, we found the weight of the stone to be 4, $\frac{1}{2}$, $\frac{1}{16}$, $\frac{1}{64}$ carats. The weights effecting the equipoise, 1, $\frac{1}{4}$, $\frac{1}{32}$, $\frac{1}{64}$ carats. We have, therefore, $\frac{293}{64} \div \frac{83}{64}$, or $\frac{293}{83} = 3{\cdot}53$, which is the specific gravity required. This would indicate the specific gravity of a Diamond. In the preceding pages the specific gravity of each stone has been given at the end of its chapter.

Jolly's spring-balance, an instrument made in Munich, is often now used by mineralogists on the Continent, and enables the specific gravity of small specimens to be determined with great rapidity. There are various other methods for determining this physical constant, but the above will suffice for ordinary purposes. Care should always be taken to have the stone perfectly clean, and carefully damped before operation.

THE HARDNESS OF GEMS.

To this property we are indebted for the durability of lustre enjoyed by the gems, in proportion so immensely superior to that of every other natural or artificial product employed as personal ornaments. The lustre of the Diamond may be closely imitated by art; but the hardness of this stone is a character that defies imitation.

An Austrian mineralogist named Mohs, many years ago suggested a scale of hardness for the testing of minerals, which is generally used by mineralogists. At the head of his scale

stands the Diamond, and the various degrees are ranged as follows:—10, Diamond; 9, Sapphire; 8, Topaz; 7, Quartz; 6, Felspar; 5. Apatite; 4, Fluorspar; 3, Calcite; 2, Gypsum; 1, Talc.

To ascertain the hardness of a stone, it is rubbed over an edge of another stone of known hardness. If it scratches, say, No. 7, but is scratched by No. 8, its hardness will lie between the two numbers. If it neither scratches nor is scratched by it, the two are identical in degree of hardness. Simple as the test seems to be, it requires considerable skill in some cases to obtain satisfactory results.

To the student of Precious Stones, it is only the first four degrees of hardness that are of interest. It is convenient to have representatives of these mounted in tubes, or handles, for ready use. The Diamond (No. 10) scratches every other stone. The Sapphire (No. 9) stands next in hardness to the Diamond, and scratches all inferior stones. The Topaz (No. 8) and the Rock Crystal (No. 7) are the only other minerals likely to be of service, any substance which can be scratched by Rock Crystal being practically of no value as a Precious Stone.

The Optical Properties of Gems.

The optical properties of Gems are of paramount importance. It is to these properties that the Diamond owes its superlative brilliancy and its flashing forth of "living fire;" to these properties, too, the Ruby, owes its intensity and delicacy of hue and beauty; in a word, the optical characters constitute a great gulf that divides the real stone from the imitation.

Reflection.

When a ray of light impinges upon the surface of a gem, part of it passes through it, in accordance with well-known optical

laws, and part of it is thrown back or *reflected*, in obedience to the following laws :—

(*a.*) The angle of reflection is equal to the angle of incidence.

(*b.*) Both the incident and the reflected ray are in the same plane, and this is perpendicular to the reflecting surface.

The amount of light thus reflected is different in different gems, and it varies also in proportion to the obliquity with which the incident ray falls upon the stone. The amount of light reflected increases up to a certain angle—differing in different stones; and under certain conditions *total reflection* takes place. To this property is due the superior brilliancy of the Diamond, as every incident ray which strikes at a greater angle than 24° 13′ is totally reflected from its internal faces. We thus see the supreme importance of cutting a Diamond, not only of a graceful and handsome outline, but having each facet cut with such mathematical precision as to secure the greatest amount of reflection from its internal surfaces.

Refraction.

Leaving the reflected part of the ray, and passing on to notice that part which is transmitted through the gem, we find that this transmission is regulated by laws which may be thus enunciated :—

(*a.*) A ray of light passing from a rarer into a denser medium (as from air into a gem) is bent or *refracted towards* a line drawn perpendicular to the plane which divides them : and *vice versa.*

(*b.*) The sines of the angles of incidence and refraction bear a constant relation to one another for each substance, which relation is known as its *refractive index* or *index of refraction.* It is to this property that lenses owe their magnifying power ; the higher the indices, the higher the magnifying power. The *refractive index* of the Diamond is the highest of any well-known

substance. It was the high refractive index of the Diamond that led Newton to suspect its composition, as explained in the foregoing pages under the head of Diamond. Sir D. Brewster gives the following as the refractive indifices (for the yellow ray) of several gem-stones compared with glass :—

Diamond ...	2·75	Chrysoberyl ...	1·76
Zircon	1·95	Spinel ...	1·75 to 1·81
Ruby	1·77	Crown Glass ...	1·5

Dispersion.

When a ray of common white light passes through a transparent medium, it may suffer decomposition, and be split up into its component colours. If the medium be properly shaped, this decomposition of the light is rendered evident, and in place of the white light which entered, there emerges a beautiful group of all the prismatic colours of the rainbow.

This act of splitting up is called the *Dispersion* of light. It is the phenomenon familiar to all in a chandelier drop. As might be anticipated, the dispersion is highest in the Diamond; in fact, the dispersive power of this stone is more than three times as great as that of rock crystal. It is upon this property that the matchless quality called *fire* in the Diamond depends. The lower the dispersive power, the less fire in the gem; the higher the dispersive power, the more brilliant and iridescent is the fire which it reflects from its surfaces. The dispersive power of certain kinds of glass or paste may be very high, but their softness renders them comparatively worthless for ornamental purposes.

Double Refraction.

The Diamond, Spinel, Garnet, and all other substances crystallizing in the Isometric or Cubic System, or those occurring in the amorphorus condition, normally possess only *simple refraction.* The rest of the gems, which crystallize in systems other than the

cubic, are said to exhibit ***double*** refraction : that is to say, when a ray of light passes through them, it is split up into two rays, one of which—called the ***ordinary*** ray—follows the laws of refraction just described, while the other—called the ***extraordinary*** ray—follows a totally different law. This splitting or dividing of the ray depends upon the direction in which the light is transmitted through the gem; there being a certain position in which the ray suffers no division, and the substance then simply acts as an ordinary medium, possessing single refraction; this direction is called ***the axis of double refraction***, or ***the axis of no refraction***, or the *optic axis*. On looking at a small bright flame through a transparent gem-stone, the flame will, if it be a simply refracting stone, appear single, and if a doubly refracting stone, double. This is, however, a rough test; the stone must be moved from the eye till the effect is obtained; and the facets of a cut stone render the determination extremely difficult.

Polarization.

There is an important series of changes that light is subject to, kuown to physicists as *Polarization*. A full description of this phenomenon cannot be given here; but there are several interesting facts that may be mentioned.

When a ray of light falls upon a reflecting surface at a certain angle, and thence on to another similar surface, at a similar angle, it will be found that when the second surface is parallel to the first, the ray will be reflected from its surface; but when the position of the second surface is turned round so as to be vertical, the ray will no longer be reflected, and will therefore disappear. Under these conditions, the ray as it leaves the first surface is said to be *Polarized;* and the angle at which this is effected is called the *Polarizing angle*. This is different in different stones: for glass it is 54° 35′; for Quartz, 57° 32′; for Diamond, 68°—the angles being measured from a normal to the reflecting surface. To determine the polarizing angle of a gem, we have simply to

reflect a ray of light from its surface at such an angle that it shall refuse to be reflected by a plate of glass inclined at 35° 25′ to the ray, when the plane of incidence is at right angles to the plane of reflection.

When a ray of light is split into two rays by its passage through a doubly refracting medium, the two are polarized; and the well-known instrument, called a "Nicol's prism," conveniently enables the observer to obtain one of these polarized rays apart from the other.

There is another remarkable property of gems depending upon polarization and double refraction, and known as *Pleiochroism.* This can be made an invaluable aid in the identification of gems, by the help of a little instrument called the Dichroiscope.

Pleiochroism.

Pleiochroism is a term used to express the existence of a plurality of colours in one and the same stone, when viewed by transmitted light under certain conditions. The mineral called *Dichroite* and some other stones, such as certain Sapphires and Tourmalines, show this difference of tint to the unaided eye, but in most cases the instrument called a dichroiscope is needed for its detection. The dichroiscope is constructed as follows:—A cleavage Rhombohedron of Iceland spar, with its end faces ground and polished, so as to be perpendicular to the length of the prism, is fitted into a small cylinder a few inches in length. At one end is a sliding cap with an aperture, usually square, perforated through its centre. At the other end is a lens, or combination of lenses, of such focal length that when the sliding cap is pulled out, say a quarter of an inch, it will show a distinct image of the aperture. If a stone be introduced in front of the aperture, two images will be seen, and these will be of the same or of different hues, according to the optical characters of the stone. Those minerals which crystallize in the Cubic system such as Diamonds, Garnets, and Spinels, show a pair of images identical in colour. But all Precious Stones crystallizing in any

of the other systems show, except when viewed in the direction of the optic axis, two images, the colours of which differ to a greater or less extent. This property of exhibiting two colours is called *dichroism*, and the stone possessing it is said to be *dichroic*.

The following is a list of the principal gems which shew twin colours when seen with the dichroiscope, as given by Prof. Church :—

NAME OF STONE.		TWIN COLOURS.	
Sapphire	(blue)	Greenish straw	Blue
Ruby	(red)	Aurora red	Carmine red
Emerald	(green)	Yellowish green	Bluish green
Beryl	(pale blue)	Sea green	Azure
Aquamarine	(sea green)	Straw white	Grey blue
Chrysoberyl	(yellow)	Golden brown	Greenish yellow
Tourmaline	(red)	Salmon	Rose pink
,,	(green)	Pistachio green	Bluish green
,,	(blue)	Greenish grey	Indigo blue
Peridot	(olive green)	Brown yellow	Sea green
Topaz	(sherry-yellow)	Straw yellow	Rose pink

APPENDIX B.

GENERAL REMARKS UPON THE TERM "CARAT," &C.

THE word Carat is probably derived from the name of a bean, the fruit of a species of *Erythima*, which grows in Africa. The tree which yields the fruit is called by the natives "Kuara" (Sun), and both blossom and fruit are of a golden colour. The bean or fruit when dried, is nearly always of the same weight, and thus in very remote time it was used in Shangallas, the chief market of Africa, as a standard of weight for gold. The Beans were afterwards imported into India, and were there used for weighing the Diamond.

The *Rati* is 89 per cent. of a carat; or, more precisely—

One Rati = 0·89062 Carat; and

One Carat = 1·2280 Rati.

The *Thola* is about 57 carats.

The ounce weight is used for weighing Baroque Pearls, Coral, and other Semi-Precious Stones.

The Carat is not of the same weight in all countries, *e.g.* :—

One carat in England and her Colonies = 205·4090 milligrams.

„	France ...	„	...	205·5000	„
„	Vienna ...	„	...	206·1300	„
„	Berlin ...	„	...	205·4400	„
„	Frankfort-on-Maine		...	205·7700	„
„	Leipzig ...	„	...	205·0000	„
„	Amsterdam	„	...	205·0000	„
„	Lisbon ...	„	...	205·7500	„
„	Leghorn ...	„	...	215·9900	„
„	Florence ...	„	...	195·2000	„
„	Spain ...	„	...	105·3930	„
„	Borneo ...	„	...	105·0000	„
„	Madras ...	„	...	207·3533	„

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72 carats make ... ... One Cologne oz.

151½ carats make ... One English oz. troy.

INDEX.

WORKS

BY

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